

HP StorageWorks Enterprise Modular Storage RAID Array Fibre Channel Arbitrated Loop Configurations for Windows, Tru64, and Sun Solaris

Product Version: 8.8-1

Second Edition (March 2005)

Part Number: AA-RS1ZB-TE

This document provides examples of typical Enterprise Modular Storage RAID Array configurations. For the latest version of these Application Notes and other ACS documentation, visit the HP storage web site at <http://www.hp.com/country/us/eng/prodserv/storage.html>.

© Copyright 2002–2005 Hewlett-Packard Development Company, L.P.

Hewlett-Packard Company makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Hewlett-Packard shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

This document contains proprietary information, which is protected by copyright. No part of this document may be photocopied, reproduced, or translated into another language without the prior written consent of Hewlett-Packard. The information contained in this document is subject to change without notice. The only warranties for HP products and services are set forth in the express warranty statements accompanying such products and services. Nothing herein should be construed as constituting an additional warranty. HP shall not be liable for technical or editorial errors or omissions contained herein.

Intel® and Itanium® are trademarks or registered trademarks of Intel Corporation in the U.S. and other countries and are used under license.

Microsoft®, MS-DOS®, MS Windows®, Windows®, and Windows NT® are U.S. registered trademarks of Microsoft Corporation.

UNIX® is a registered trademark of The Open Group.

Hewlett-Packard Company shall not be liable for technical or editorial errors or omissions contained herein. The information is provided "as is" without warranty of any kind and is subject to change without notice. The warranties for Hewlett-Packard Company products are set forth in the express limited warranty statements for such products. Nothing herein should be construed as constituting an additional warranty.

Enterprise Modular Storage RAID Array Fibre Channel Arbitrated Loop Configurations for Windows, Tru64,
and Sun Solaris Application Notes
Second Edition (March 2005)
Part Number: AA-RS1ZB-TE

About this Document

This section describes the content reflected in this document, including:

- [“Application Notes Contents”](#) on page 4
- [“Intended Audience”](#) on page 4
- [“Related Documentation”](#) on page 5

Application Notes Contents

This application note covers the following major topics:

- [“Enterprise Network Storage Architecture \(ENSA\)”](#) on page 5
- [“Product Overview”](#) on page 6
- [“HP StorageWorks RAID Product Details”](#) on page 7
- [“Configuration Notes”](#) on page 8
- [“Configuration Example–Windows NT/2000”](#) on page 12
- [“Appendix A: Examples of HA Configurations”](#) on page 25
 - [“HSun Solaris”](#) on page 25
 - [“HA Application Options for Sun Solaris”](#) on page 28
 - [“Tru64 UNIX”](#) on page 29
- [“Appendix B: Microsoft Cluster Server \(MSCS\)”](#) on page 34
- [“Appendix C: Controller Failover Transitions”](#) on page 55
- [“Appendix D: Arbitrated Loop Physical Addresses”](#) on page 60

[Table 1](#) describes where to find examples of specific operating system configurations:

Table 1: Where to find specific configurations by operating system

Operating System	Specific Configurations Begin on
Sun Solaris	page 25 (High Availability); page 28 (Veritas Cluster)
Tru64 UNIX	page 29 (High Availability)
Windows NT/2000	page 12; page 34 (Microsoft Cluster Server)

Intended Audience

Storage administrators should have the following experience:

- configuring RAID storage systems, specifically using the Command Line Interface (CLI);
- experience in using the individual operating systems; and
- an understanding of Fibre Channel terminology and concepts.

Related Documentation

In addition to this FC-AL Application Note, additional information can be found in:

- ACS V8.8 controller documentation
- *HP StorageWorks HSG60 and HSG80 Array Controller and Array Controller Software Command Line Interface Reference Guide*, EK-G80CL-RA. C01
- *HP StorageWorks HSG60 and HSG80 Array Controller and Array Controller Software Maintenance and Service Guide*, EK-G80MS-SA. C01
- *HP StorageWorks HSG60 and HSG80 Array Controller and Array Controller Software Troubleshooting Guide*, EK-G80TS-SA. C01
- SWCC V2.5 documentation (client software delivered in solutions kits)
- *HP StorageWorks Command Console User Guide*, AA-RV1UA-TE
- *HP Storage Works Command Console Release Notes*, AV-RV1TA-T
- Command Console Help Files, AA-RS20A-TE and AA-RS21A-TE
- Host-specific documentation (SWCC Agent and HBA software delivered in solutions kits)
- Installation and Configuration Guide for each operating system
- Solution Software Release Notes for each operating system

Additional support required by HSG80 ACS Solution Software V8.8, but delivered through external programs, include the following:

- Heterogeneous “rules based” SAN configurations
- Host-Bus Adapter (HBA) products
- Applicable Storage Utility Management Suite (SUMS) components
- Vendor-specific switch products
- Data Replication Manager (DRM) under ACS V8.8P
- Enterprise Volume Manager (EVM) under ACS V8.8S
- Enterprise Backup Solution (EBS)

Enterprise Network Storage Architecture (ENSA)

Enterprise Modular Storage RAID Array (RA/MA8000 and ESA/EMA12000) products are the latest in fully integrated Fibre Channel RAID storage solutions. These products provide the key initial step in delivering the HP's ENSA vision. ENSA addresses the issues that customers expect to face now and in the future.

Product Overview

The Enterprise Modular Storage RAID Array Fibre Channel systems are based on a common architecture and offer customers centralized management, high availability, exceptional performance and scalability in open systems environments. These products provide a Fibre Channel storage solution with industry leading Storage Area Network (SAN) support using Fibre Channel Arbitrated Loop (FC-AL) technology.

Note: HP supports systems that are currently configured with FC-AL. No new configurations with FC-AL are supported.

The RA/MA8000 Fibre Channel is a mid-range storage system available in a pedestal enclosure for departmental use in the office. It can also be installed in server racks for data centers. An easy-to-deploy, flexible solution for open systems, the RA/MA8000 currently supports up to 1.3 TB of storage with the use of 18GB disks.

The ESA/EMA12000 Fibre Channel, designed for the data center, is available in three easy-to-order building blocks, each optimized for specific, high-capacity customer requirements. The ESA/EMA12000 Fibre Channel offers unprecedented levels of storage, scaling in performance and capacity as user requirements increase.

These storage systems incorporate the latest in RAID technology providing RAID levels 0, 1, 0+1, adaptive 3/5, and non-RAID disks. The implementation of RAID capability assures that data availability will be maintained despite hardware failure. Features such as read-ahead cache and mirrored write-back cache improve performance while preserving data and high availability support.

Platform kits include software and documentation created for each specific operating system that can be used with the HP StorageWorks RAID arrays.

The platform kits contain the necessary operating system software and documentation needed to install, configure, and monitor your storage system. All kits include the HP StorageWorks Command Console (SWCC) for storage management operations including configuring, status inquiry and notification facilities.

HP StorageWorks RAID Product Details

The Enterprise Modular Storage RAID Array systems use the HSG80 RAID controller running Array Controller Software (ACS) V8.8. The ACS software is designed to support multiple platforms providing features including: dual controller operation, two controller failover modes – Transparent and Multiple-Bus, mirrored write back cache, read ahead cache, RAID implementation, disk mirroring, and disk partitioning capabilities. In addition, ACS manages host interconnect and protocol services to provide data for event notification and status as displayed by SWCC.

The HSG80 controller has two Fibre Channel host ports providing up to a total of nearly 200 Mbytes per second of available bandwidth. Disk drives are connected to the controller through 6 UltraSCSI channels providing up to 40 Mbytes per second per channel of available bandwidth. Servers can use multiple host bus adapters (host bus adapters) to multiple RA/MA8000 Fibre Channel systems for unlimited storage capacity.

RA/MA8000 Fibre Channel controllers come with 64 MB of cache. Cache options allow for 128 MB, 256 MB and 512MB of cache in each controller. ESA/EMA12000 Fibre Channel controllers come with 256 MB of cache. Cache options allow for 512MB of cache in each controller. Cache features include read ahead and mirrored write back cache for use in optimizing performance where redundant capabilities are required for high availability system configurations. In the rare event that a storage controller fails the mirrored data is immediately available to the remaining controller for continuing operation.

The RA/MA8000 Fibre Channel pedestals and rackables come in both single controller and in dual controller models to allow the customer to select the level of high availability required for his application. A single controller model can be upgraded to a dual controller model when warranted by the application.

High availability is supported by the use of redundancy and hot swappable components. The RA/MA8000 Fibre Channel disk enclosures include redundant cooling, and have 5 power supplies providing N+1 redundancy. Power can be upgraded to full redundancy with the addition of 3 more supplies and a 2nd power distribution unit for AC input redundancy. HP StorageWorks components are “hot” swappable including storage controllers when operating as a redundant pair.

The Enterprise Modular Storage RAID Array Fibre Channel can be configured and monitored using the HP StorageWorks Command Console (SWCC). SWCC is included in the HSG80 Software Solutions Platform kit. Using this client/server tool, RAID sets can be configured locally or over a TCP/IP network. The client provides an easy to use graphical interface. It can be used to monitor the RAID storage systems and notify you of events by updating a video display, sending electronic mail or alerting via a pager. The Command Console Client includes applications (or Storage Windows) that communicate with the Command Console Agent software running on the server/host platform.

The Command Console client is available on Windows 95/98 and on Intel platforms running Windows NT/2000. A Storage Window for the HSG80 controller supports the Array Controller Software (ACS) V8.8 and offers integration with HP's Insight Manager (CIM). Insight Manager can receive SNMP traps from the Command Console Agent and Insight Manager services can directly launch SWCC for notification or configuring operations.

Configuration Notes

- All single controller storage configurations can be upgraded to dual controller configurations.
 - Controller pairs can be configured for either Dual Redundant Failover Mode *or* Multiple-bus Failover Mode. When controllers are in Dual Redundant Failover Mode, this is referred to as “Transparent Failover Mode.”
 - All configuration diagrams show a frontal view of the storage system.
 - Controller Host Port 1 is the left port; Controller Host Port 2 is the right port.
 - Controller A is the top controller; Controller B is the bottom controller.
 - Each storage system can be configured using the HP StorageWorks Command Console (SWCC) or the Command Line Interface (CLI) with the HSG80 controller maintenance serial port or a TCP/IP interface.
 - All configurations require Array Controller Software (ACS) V8.8 for the FC-AL topology.
 - All configurations require RA/MA8000 or ESA/EMA12000 Fibre Channel Solution Software V8.8 for the particular operating system.
 - All configurations use short wavelength lasers and multi-mode Fibre Channel optical cables. They do not include Fibre Channel Switch technology or single-mode optical cables and long wavelength laser technology. Additionally, cascading Fibre Channel hubs are not supported in these configurations.
 - All configurations require Arbitrated Loop Physical Addresses (ALPAs). There is one ALPA for each device on a loop. Each ALPA is configured as LOOP_HARD and must be unique. (See Appendix D: Arbitrated Loop Physical Addresses.)
 - Controller Defaults: Host Port 1 has an ALPA of 71; Host Port 2 has an ALPA of 72.
 - In configurations with two Storage Systems, this document uses the following convention for:
 - first Storage System, ALPA D5 for Port 1 and ALPA D6 for Port 2; and,
 - second Storage System: ALPA D3 for Port 1 and ALPA D4 for Port 2.
- ```
Set controllername port_1_topology=loop_hard
Set controllername port_1_al_pa=71
Set controllername port_2_topology=loop_hard
Set controllername port_2_al_pa=72
Set connection name operating_system=WINNT (or HP)
```
- All configurations require the connection name operating system parameter to be set to (operating system). (Example, CLI: SET *connection-name* OPERATING\_SYSTEM = WINNT)
  - By default the HSG80 Command Console LUN (CCL) is enabled. You can disable it (in SCSI-2 mode) using the CLI command (CLI: SET *controller* NOCOMMAND\_CONSOLE\_LUN).
  - The HSG80 controllers support a range of 200 unit numbers. In Transparent Failover Mode, the units D0–D99 are assigned to Port 1 and units D100–D199 are assigned to Port 2. In Multiple-Bus Failover Mode, all 200 unit numbers may be visible to all ports. Connection offsets are used to restrict access/visibility.
  - For configurations with more than one server on the same loop:
    - Use the SET *connection-name Unit\_Offset* value to set the range of unit numbers to be visible from each Server (CLI: SET *connection-name* UNIT\_OFFSET = *n*) This will provide a first level of access control from Server to Storage.

- To define a second level of access control from Server to Storage, it is possible to define a specific combination of Storage Unit and Host by enabling an ACCESS\_PATH. The steps are: (1) Disable/Clear all current access\_paths, (CLI: SET *unit-number* DISABLE\_ACCESS\_PATH = ALL); and, (2) Set a specific Host access (through the connection name), (CLI: SET *unit-number* ENABLE\_ACCESS\_PATH = *connection-name*).
- For single controller configurations with two active controller host ports on the same loop, use the *connection-name Unit\_Offset* value to set the range of unit numbers to be visible from controller host port 2.
- For two storage system (4 controller) configurations with more than one controller host port on the same loop, set the ALPA for each controller host port in the second enclosure to a different LOOP\_HARD address (CLI: SET *controller* PORT\_1\_AL\_PA = *xy*)
- Record the Fibre Channel HBA Worldwide Identification (WWID) address. Some HBAs display the WWID on the HBA itself.
- Use the recorded WWID to identify the connection name displayed from the CLI at the controller using the CLI: SHOW CONNECTIONS command.
- By default, new connection names are automatically added to the controller connection name table as !NEWCON*nn* (where *nn* is a number from 1 to 32). The controller adds a connection when a path to an adapter from each active controller host port is detected. Once you have identified each connection using the Fibre Channel HBA WWID, rename the connection names to a name meaningful to the specific configuration. (CLI: RENAME *old-name new-name*. Connection names may contain nine (9) characters). In some cases, host name and Port value may suffice (WESTP1, WESTP2, EASTP1, EASTP2, etc.).
- Each active controller host port on a loop presents one SCSI Target ID with up to sixty-four (64) LUNs to each Fibre Channel HBA on the same loop. LUNs (logical units) can consist of single disks (JBOD), a storage set of multiple disks or a partition (up to 64), configured for a specific RAID level of 0, 0 + 1, or 3/5.
- There are two points of view when speaking of Fibre Channel connections:
  - The first view is taken from the server side. The server has a configuration file that allows the operating system to identify targets and logical units used for I/O. The targets and logical units may be configured as desired within the maximum values for the operating system and restrictions of the Fibre Channel specifications. This means that while there may be 6 targets (ALPAs) on a Fibre Channel arbitrated-loop, the configuration file may/may not list all 6 targets. In short, a specific server may not look for or try to access a specific target.
  - The second view is from the controller side. On a loop, the controller knows about each host-adapter combination (HAC) that it can communicate with. The controller creates one connection on each active controller port for each HAC. Thus, if there are four servers on a loop, each with a Fibre Channel adapter, the controller will create four connections for the servers for each active controller port. If there is one active port, the controller will establish 4 connections. If there are two active ports, the controller will create 8 connections.

By combining the server and controller viewpoints, there is the flexibility of using all connections. If all the targets in the server's configuration file are defined and mapped to all available connections, there is complete use of the available connections. On the other hand, if access is restricted from the server point of view, server configurations may be edited so that there are fewer targets than connections available, leaving unused connections. Those connections are still available, but for reasons of load balancing or access control, are not used.

In the configurations of this application note, the server's point of view is used to limit access to certain targets. This also means that when implementing a configuration, only the connections used need to be identified, not all of them. Thus, the naming of connections is done for only those connections that are active in the specific configuration. Disregard the unused connections.

---

**Note:** The CLI provides the ability to delete a connection. This deletion is good ONLY until the controller reinitializes. When a controller reboots, it rebuilds its connection table for all devices that it can access.

---

## Configuration Maximums

HSG80 controller maximum configuration rules include:

- 128 visible LUNs/200 assignable unit numbers
  - SCSI-2 mode, if the CCL is enabled, the result is 127 visible LUNs and one CCL.
  - (Windows platform only) SCSI-2 mode, the CCL is disabled, resulting in 128 visible LUNs.
  - SCSI-3 mode, the result is 126 visible LUNs and two CCLs.
  - (Windows platform only) SCSI-3 mode, the CCL is enabled, resulting in 127 visible LUNs for multiple-bus (126 visible LUNs for transparent failover) and one CCL.
- 1.024 TB storageset size
- 96 host connections
- 72 physical devices for BA370-based packaging; 84 physical devices for all others
- 20 RAID 3/5 storagesets
- 30 RAID 3/5 and RAID 1 storagesets (see note)
- 48 RAID 3/5, RAID 1, and RAID 0 storagesets (see note)

---

**Note:** The previous two configuration rules before this note are subject to a combined maximum, in that the 30 RAID 3/5 and RAID 1 storageset combination and the 45 RAID 3/5, RAID 1 and RAID 0 storageset combination are limited to no more than 20 RAID 3/5 storagesets in the individual combination.

---

- 8 partitions of a storageset or individual disk
- 6 physical devices per RAID 1 storageset (mirrorset)
- 14 physical devices per RAID 3/5 storageset (RAIDset)
- 24 physical devices per RAID 0 storageset (stripeset)
- 48 physical devices per RAID 0+1 storageset (striped mirrorset)
- 146 GB disks are the largest supported for the HSG60 and HSG80 storage array.

The Fibre Channel Loop maximum configuration rules include:

- 500 meters per optical cable segment, 50 micron, multi-mode.  
175 meters per optical cable segment, 62.5 micron, multi-mode.
- 1 kilometer distance between Server and Storage.

- 4 Fibre Channel Host Based Adapters per loop.

The Transparent or Multi-Bus Failover Mode maximum configuration rules include:

- 4 Servers on a single FC-AL loop
  - 2 Storage Systems
  - 4 Controllers with 2 Active controller ports per controller pair
- 8 Servers on two FC-AL loops
  - 1 Storage System per loop
  - 2 Controllers with 2 Active controller ports

## Configuration Example–Windows NT/2000

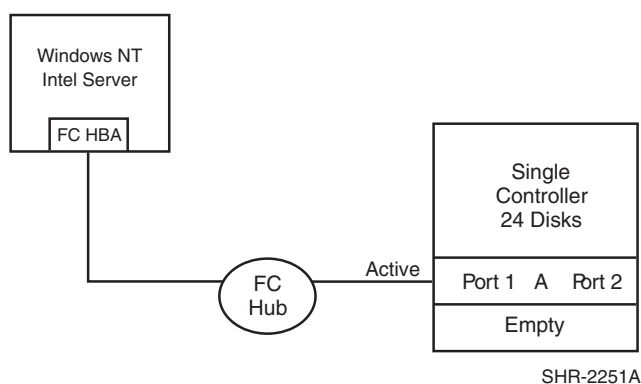
Table 2 lists the most common Enterprise Modular Storage RAID Array Fibre Channel configurations. Windows NT/Windows 2000 configurations are used for these examples.

**Table 2: Typical RA/MA8000/ESA/EMA12000 FC-AL Windows NT/2000 configurations**

| Configuration # | Description                                                                                   |
|-----------------|-----------------------------------------------------------------------------------------------|
| 1               | One Server, Single Controller                                                                 |
| 2               | One Server, Dual Controller, Transparent Failover                                             |
| 3               | One Server, Two Dual Controller Pairs, Transparent Failover                                   |
| 4               | Two Servers, Single Controller, Shared Storage Enclosure                                      |
| 5               | Two Servers, Dual Controller, Transparent Failover, Shared Storage Enclosure                  |
| 6               | Up to Four Servers, Dual Controller, Transparent Failover, Shared Storage Enclosure           |
| 7               | Up to Four Servers, Two Dual Controller Pairs, Transparent Failover, Shared Storage Enclosure |
| 8               | Up to Eight Servers, Dual Controller, Transparent Failover, Shared Storage Enclosure          |

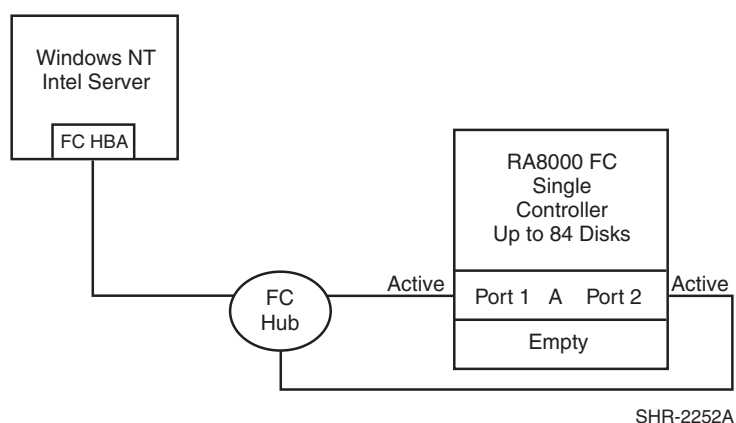
### One Server, Single Controller

The single controller configuration (Figure 1) is an entry-level Enterprise Modular Storage RAID Array that can be expanded to accommodate additional storage capacity or performance needs as required. The configuration consists of an Enterprise Modular Storage RAID Array enclosure with a single HSG80 array controller on a single Fibre Channel loop. In the initial configuration a single controller host port (Port 1) is active providing up to 8 large LUNs across up to 84 disks. An additional 48 disks can be added using two expansion enclosures. Additional servers can be added to this configuration as required using the existing hub (refer to Configuration 6 in [Table 2](#)).



**Figure 1: Configuration 1**

LUN capacity can be doubled by the use of a third Fibre Channel cable connected to the second controller host port (Port 2), resulting in the configuration shown in Figure 2.



**Figure 2: Configuration 1 with double LUN capacity**

## Configuration 1 Notes

- Single Fibre Channel loop
- This configuration consists of a single HSG80 controller, controller failover is not available
- Up to 500 meters per cable segment
- Up to 84 disks with 2 optional expansion enclosures
- Without large LUNs, up to 8 LUNs with 1 active controller host port (first diagram). Suggested controller unit number assignment: Port 1 units D0–D7. In this configuration, 1 logical connection is available.
- Without large LUNs, up to 16 LUNs with 2 active controller host ports (second diagram). Suggested controller unit number assignment: Port 1 units D0–D7, Port 2 units D100–D107. In this configuration, 2 logical connections are available.
- Utilization of controller host port 2 requires a third cable and enabling of the port through the Command Line Interface (CLI) using the following commands:
 

```
SET THIS PORT_2_TOPOLOGY = LOOP_HARD
SET THIS PORT_2_AL_PA = 72
```
- In the Figure 1 configuration, one logical connection is available
- In the Figure 2 configuration, two logical connections are available
- Rename the connection names, for example: SERVER1P1, SERVER1P2
- Set the connection name unit offset value for port 2, SET SERVER1P2 UNIT\_OFFSET = 100

## Configuration 1 Performance Considerations

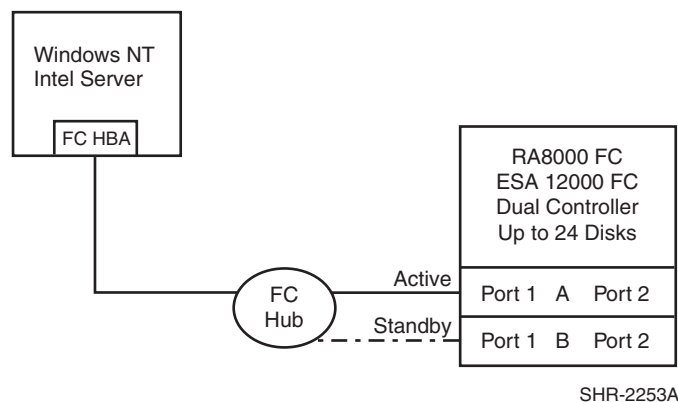
The configuration as shown in Figure 1 uses a single controller host port. This results in a throughput limit of 12,000(cache)/4,100(media) I/O/sec and a data rate limit of 77(cache)/54(media) MB/sec. using the second controller host port, as shown in Figure 2, results in a performance increase up the Fibre Channel Host Bus Adapter limit of 86 MB/sec for data rate. The I/O rate limit however would be maintained at the single controller limit of 12,000(cache)/4,100(media) I/O/sec.

This is a general-purpose configuration that can be used for typical I/O applications and typical bandwidth applications. Using the second controller host port will increase performance to allow for moderately intensive I/O and moderately intensive bandwidth applications.

An alternative to the configuration shown in the second diagram is to segregate the controller host ports on separate loops by adding a second Fibre Channel Host Bus Adapter in the server and connect this to a second separate hub cabled to controller host Port 2. This would increase the performance to the single controller 2 active port limit of 98(cache)/54(media MB/sec. The I/O/sec rate would remain at 12,000(cache)/4,100(media) I/O/sec.

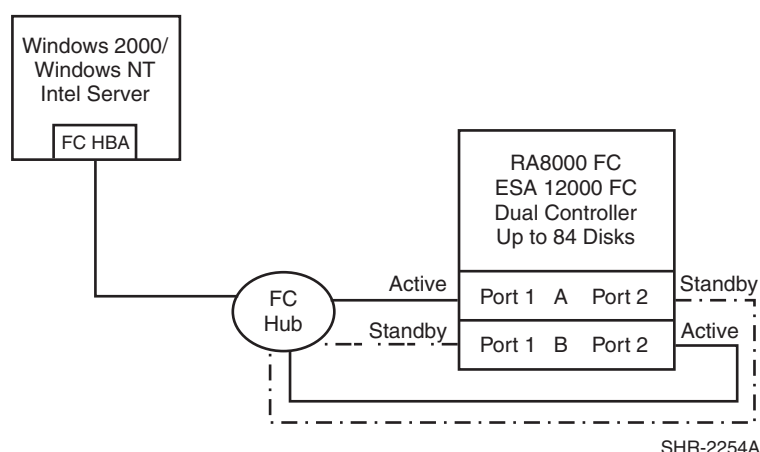
## One Server, Dual Controller, Transparent Failover

This two-controller configuration (Figure 3) provides dual redundant controllers configured in Transparent Failover mode. The configuration consists of an Enterprise Modular Storage RAID Array enclosure with two HSG80 array controllers on a single loop. In normal operation Controller A provides the active path for all storage sets to the server through Port 1. A second controller, Controller B is a hot standby. Controller B will automatically become active in the event of a failure in Controller A. All units being accessed through Port 1 of Controller A will become accessible through Port 1 of Controller B. In the initial configuration a single controller host port (Port 1) is active providing up to 8 LUNs across up to 84 disks. An additional 48 disks can be added using two expansion enclosures. Additional servers can be added to this configuration as required using the existing hub (refer to Configuration 6 in [Table 2](#)).



**Figure 3: Configuration 2**

Using the second controller (Controller B) as an active controller to increase performance and double LUN capacity can be accomplished without sacrificing redundancy. Two Fibre Channel cables, one connected to Controller A Port 2, and one connected to Controller B Port 2, result in the configuration shown in Figure 4. This configuration provides full controller redundancy in the event that Controller A or Controller B fails. In either failover scenario the surviving controller will transition a standby port to the active state providing access to all units to the server.



**Figure 4: Configuration 2 with increased performance and double LUN capacity**

## Configuration 2 Notes

- Single Fibre Channel loop
- Dual HSG80 controllers configured in Transparent Failover Mode
- Up to 500 meters per cable segment
- Up to 84 disks
- Up to 8 LUNs with 1 active controller host port (Figure 3). Suggested controller unit number assignment: Port 1 units D0–D7
- Without large LUNs, up to 64 LUNs with 2 active controller host ports (Figure 4). Suggested controller unit number assignment is to balance LUNs between ports.
- Using controller host Port 2 requires two Fibre Channel cables per Figure 4, Configuration 2.
- By default, setting the controller pair in Transparent Failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set the unit offset values to 0 for Port 1 and 100 for Port 2
- In the Figure 3 configuration, 1 logical connection is available.
- In the Figure 4 configuration, 2 logical connections are available.
- Rename the connection names. for example: SERVER1P1, SERVER1P2

## Configuration 2 Performance Considerations

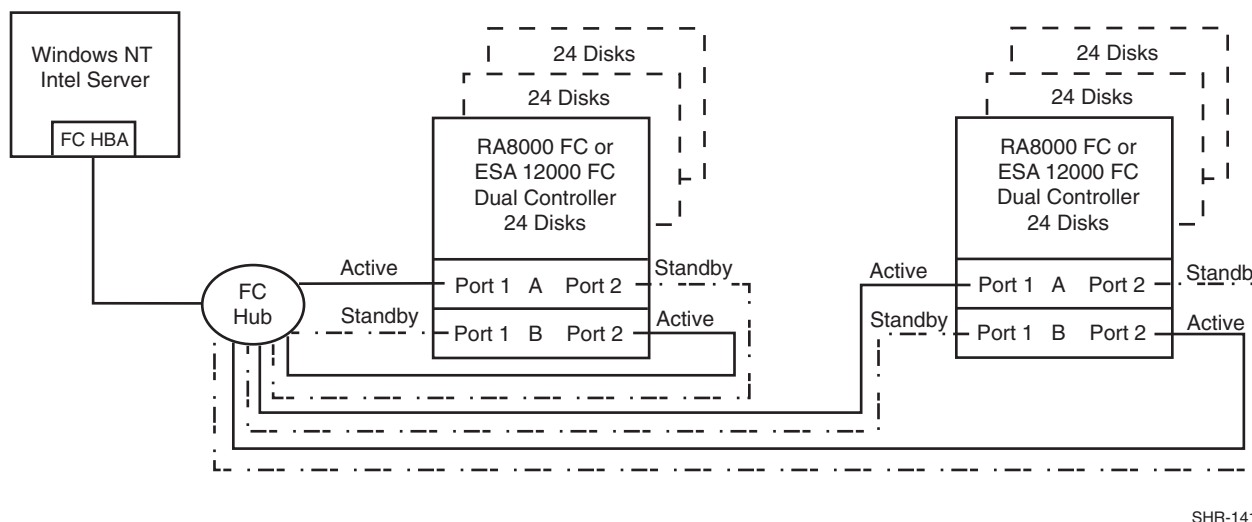
The configuration, as shown in the Figure 4, uses a single controller host port resulting in a throughput limit of 12,000(cache)/4,100(media) I/O/sec and a data rate limit of 77(cache)/54(media) MB/sec. Using the second controller host port, as shown in the Figure 4, results in a performance increase up the Fibre Channel Host Bus Adapter limit of 15,500 I/O/sec and 86 MB/sec data rate.

This is a general-purpose configuration that can be used for typical I/O applications and typical bandwidth applications. Using the second controller will increase performance to allow for moderately intensive I/O and moderately intensive bandwidth applications.

An alternative to the configuration shown in the Figure 4, is to segregate the controller host ports on separate loops by adding a second Fibre Channel Host Bus Adapter in the server and connecting to a second separate hub cabled to controller host Port 2. This would increase the performance to the dual controller 2 active port limit of 24,000(cache)/8,200(media) I/O/sec and 154(cache)/102(media) MB/sec.

## One Server, Two Dual Controller Pairs, Transparent Failover

Configuration 3 (Figure 5) is a two dual-controller configuration providing two dual-redundant controller pairs using two RA pedestal enclosures or a single ESA enclosure. The controllers are configured in Transparent Failover mode providing controller redundancy in each storage enclosure. This configuration takes advantage of the high capacity of a single Fibre Channel loop allowing for expansion of storage capacity without the addition of another hub. As with Configuration 2, full controller redundancy and two controller capacity is provided in both storage enclosures. In this configuration four active controller ports provide up to 32 LUNs across up to 48 disks. An additional 96 disks can be added using four expansion enclosures. Additional servers can be added to this configuration as required using the existing hub (refer to Configuration 7 in [Table 2](#)).



SHR-141

**Figure 5: Configuration 3**

### Configuration 3 Notes

- Single Fibre Channel loop
- Two Dual HSG80 controller pairs configured in Transparent Failover Mode
- Up to 500 meters per cable segment
- Up to 168 disks
- Up to 64 LUNs with 4 active controller host ports. Suggested controller unit number assignment: In each storage enclosure, balance units between host ports.
- By default, setting the controller pairs in Transparent Failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set the unit offset values to 0 for Port 1 and 100 for Port 2.
- In this configuration 4 logical connections are available, 2 in each enclosure.

- For each enclosure (controller pair), rename the connection names, for example: SERVER1P1, SERVER1P2, SERVER2P1, SERVER2P2, and so forth.
- For the second controller enclosure set each controller host port ALPA to a different hexadecimal address then set on the first enclosure. Suggested settings: Controller Enclosure 1 Port 1 = 71, Port 2 = 72, Controller Enclosure 2 Port 1 = 73, Port 2 = 74
- The configuration of units for both controller pairs can be set identical to that described above. This is possible because the Fibre Channel Host Bus Adapter will see each active controller host port as a unique target ID with a unique set of LUNs. Although LUN numbering is identical for each controller pair, when viewed by the server the LUNs on the active controller host ports in the second enclosure are assigned under different SCSI target IDs.

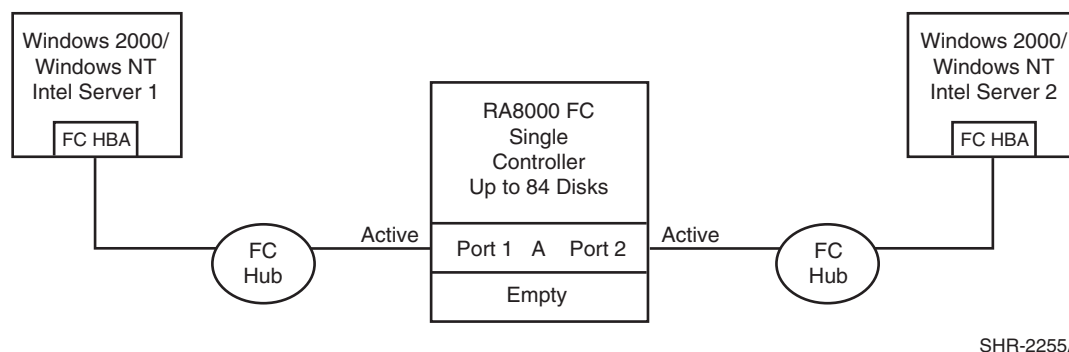
### Configuration 3 Performance Considerations

This configuration uses two dual controller pairs with an overall limit of the Fibre Channel Host Bus Adapter of 15,500 I/O/sec and 86 MB/sec data rate. The primary advantage of this configuration is the added storage and LUN capacity.

This is a general-purpose configuration that can be used for moderately intensive I/O applications and typical bandwidth applications. It is more suited for I/O intensive applications and high capacity requirements.

### Two Servers, Single Controller, Shared Storage Enclosure

Configuration 4 (Figure 6) uses the second controller host port to provide storage to a second separate (non-cooperating) server. The two servers share the storage enclosure in that each server has exclusive access to its own LUNs through the use of mutually exclusive LUN numbering. This configuration uses two separate Fibre Channel loops. Additional servers can be added to this configuration as required using the existing hubs (refer to Configuration 8 in [Table 2](#)).



**Figure 6: Configuration 4**

### Configuration 4 Notes

- Two Fibre Channel loops
- Shared storage enclosure
- This configuration consists of a single HSG80 controller, controller failover is not available.
- Up to 500 meters per cable segment

- Up to 84 disks with 2 optional expansion enclosures
- Up to 128 LUNs total, 64 available to each server with 2 active controller host ports. Suggested controller unit number assignment: balance LUNS between host ports.
- In this configuration 2 logical connections are available.
- Utilization of controller host Port 2 requires a third cable and enabling of the port through the Command Line Interface (CLI) using the following commands:  

```
SET THIS PORT_2_TOPOLOGY = LOOP_HARD
SET THIS PORT_2_AL_PA = 72
```
- Rename the connection names, for example: SERVER1P1, SERVER2P2.
- Set the connection name unit offset value for port 2, SET SERVER2P2 UNIT\_OFFSET = 100

## Configuration 4 Performance Considerations

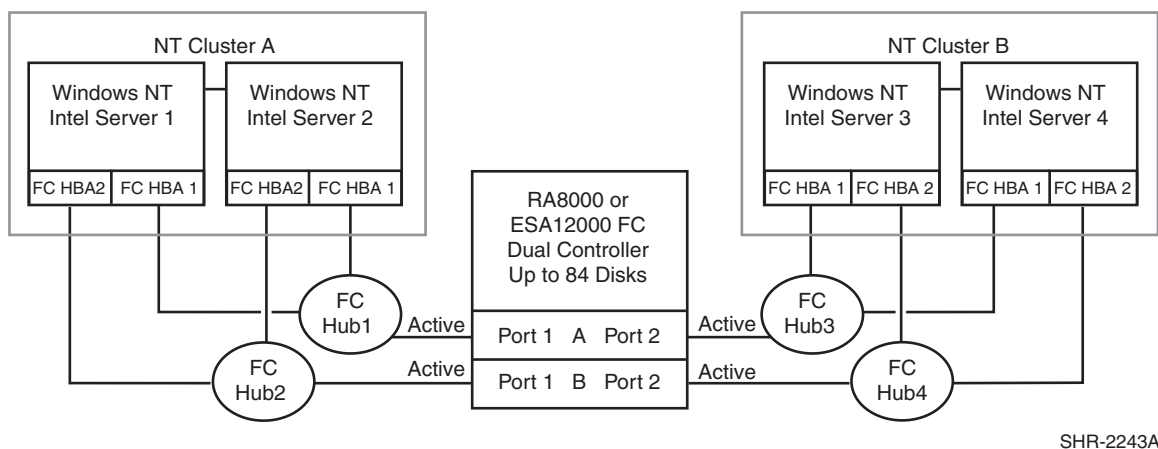
This configuration uses a single controller with two active controller host ports. The overall limit is based on the single controller, two active port limit of 12,000(cache)/4,100(media) I/O/sec and 98(cache)/54(media) MB/sec data rate. The primary advantage of this configuration is the ability to share the storage enclosure between two independent servers.

This is a general-purpose configuration that can be used for typical I/O and intensive bandwidth applications. It is more suited for bandwidth intensive applications.

## Two Servers, Dual Controller, Transparent Failover, Shared Storage Enclosure

Configuration 5 (Figure 7) uses a dual controller pair to provide storage and controller redundancy to a second separate (non-cooperating) server. The two servers share the storage enclosure in that each server has exclusive access to its own LUNs through the use of mutually exclusive LUN numbering. This configuration uses two separate Fibre Channel loops. Each server has access to its own dedicated controller. In the event of a controller failover, the surviving controller will continue to provide full access to units to both servers.

In normal operation Controller A provides the active path for all storage sets assigned to server 1 through Port 1. A second controller, Controller B provides the active path for all storage sets assigned to server 2 through Port 2. Each server also has a dedicated standby port in the event that there is a controller failover. Additional servers can be added to this configuration as required using the existing hubs (refer to Configuration 8 in [Table 2](#)).



**Figure 7: Configuration 5**

## Configuration 5 Notes

- Two Fibre Channel loops
- Shared storage enclosure
- Dual HSG80 controllers configured in Transparent Failover Mode
- Up to 500 meters per cable segment
- Up to 84 disks with 2 optional expansion enclosures
- Up to 128 LUNs total, 64 available to each server with 2 active controller host ports. Suggested controller unit number assignment: balance LUNS between host ports.
- In this configuration 2 logical connections are available.
- Rename the connection names, for example: SERVER1P1, SERVER2P2.
- By default, setting the controller pair in Transparent Failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set the unit offset values to 0 for Port 1 and 100 for Port 2.
- Utilization of the second controller host port requires a second Windows NT Intel Server, Fibre Channel host bus adapter, hub and cables.

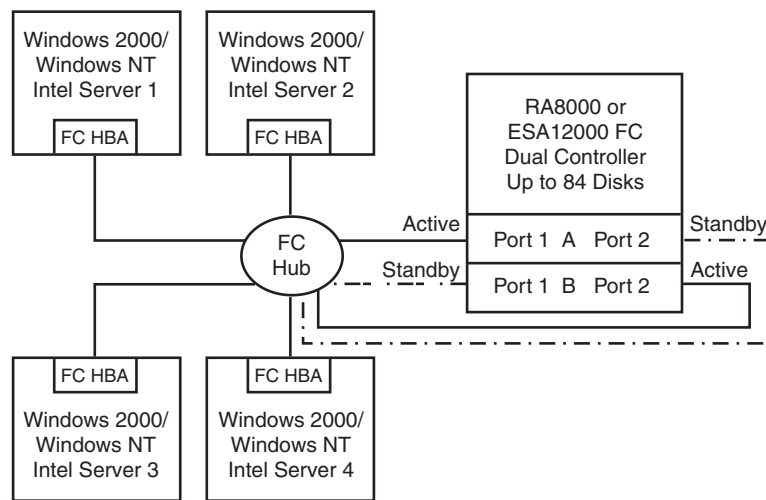
## Configuration 5 Performance Considerations

This configuration uses dual controllers with two active and two standby controller host ports. The overall limit is based on the dual controller, two active port limit of 24,000(cache)/8,200(media) I/O/sec and 154(cache)/102(media) MB/sec data rate. The primary advantage of this configuration is the ability to share the storage enclosure between two independent servers without any performance degradation.

This is a general-purpose configuration that can be used for intensive I/O applications and very intensive bandwidth applications.

## Up to Four Servers, Dual Controller, Transparent Failover, Shared Storage Enclosure

Configuration 6 (Figure 8) builds on Configurations 2 and 5 using a dual controller pair on a single loop to provide storage and controller redundancy for up to four separate (non-cooperating) servers. The four servers share the storage enclosure in that each server has exclusive access to its own set of LUNs. This is made possible by the setting of explicit “host access” at the unit level and using connection name “unit offsets” to give each server an accessible range of unit numbers. Additional levels of access control are necessary for this configuration because all servers are sharing the single Fibre Channel loop. As with all dual controller configurations, controller failover and performance benefits are inherent.



SHR-2257A

**Figure 8: Configuration 6****Configuration 6 Notes**

- Single Fibre Channel loop
- Shared storage enclosure
- Dual HSG80 controllers configured in Transparent Failover Mode
- Up to 500 meters per cable segment
- Up to 84 disks with 2 optional expansion enclosures
- Up to 128 LUNs total, 32 available to each server with 2 active controller host ports
- In this configuration 8 logical connections are available.
- Rename the connection names, for example: SERVER1P1, SERVER1P2, SERVER2P1, and so forth.
- Set the connection name unit offset values. By default, setting the controller pair in Transparent failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set unit offset values to 0 for Port 1 and 100 for Port 2. Use the default connection unit offset values for one of the servers and set new unit offset values for connections to the other three servers as shown below.
- Set exclusive unit access for each unit to a specific server connection name. For example: for unit D0 ENABLE = SERVER1P1; for unit D100 ENABLE = SERVER2P2.
- Set each Fibre Channel Host Bus Adapter ALPA to a unique hexadecimal hard address. Suggested settings: HBA1 = 01, HBA2 = 02, HBA3 = 04, HBA4 = 08.
- Suggested unit numbering and connection parameters would result in the units being distributed equally across controller host ports as follows:
 

Server 1: Port 1 units D0–D7, Port 2 units D100–D107

Connection name, unit offset value: SERVER1P1, 0. SERVER1P2, 100

Server 2: Port 1 units D10–D17, Port 2 units D110–D117

Connection name, unit offset value: SERVER2P1, 10. SERVER2P2 110

Server 3: Port 1 units D20–D27, Port 2 units D120–D127

Connection name, unit offset value: SERVER3P1, 20. SERVER3P2, 120

Server 4: Port 1 units D30–D37, Port 2 units D130–D137

Connection name, unit offset value: SERVER4P1, 30. SERVER4P2, 130

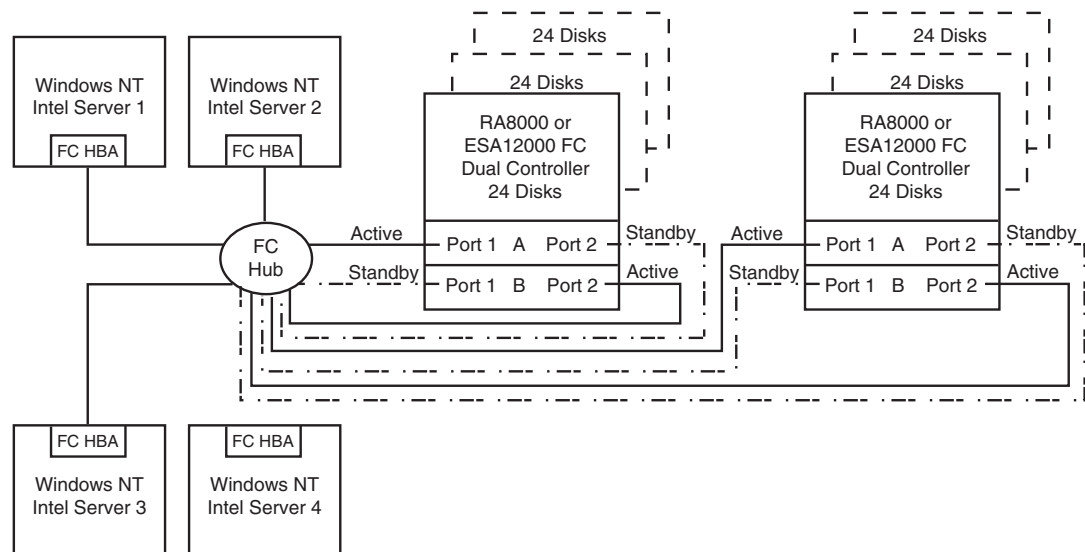
## Configuration 6 Performance Considerations

This configuration uses dual controllers with two active and two standby controller host ports. The overall limit is based on the dual controller, 2 active port limit of 24,000 I/O/sec and the theoretical single loop limit of 100 MB/sec data rate. The primary advantage of this configuration is the ability to connect up to four servers on a single Fibre Channel loop.

This is a high connectivity configuration that can be used for intensive I/O and very intensive bandwidth applications. It is more suited for bandwidth intensive applications.

## Up to Four Servers, Two Dual Controller Pairs, Transparent Failover, Shared Storage Enclosure

Configuration 7 (Figure 9) builds on Configurations 3 and 6, using two dual controller pairs on a single loop to provide storage and controller redundancy for up to four separate (non-cooperating) servers. The four servers share the storage enclosures in that each server has exclusive access to its own set of LUNs within each enclosure. This is made possible by the setting of explicit “connection name access” at the unit level and using connection name “unit offsets” to give each server an accessible range of unit numbers. Additional levels of access control are necessary for this configuration because all servers are sharing the single Fibre Channel loop. The addition of a second controller pair doubles the disk and LUN capacity available to the four servers.



SHR-1419

**Figure 9: Configuration 7**

## Configuration 7 Notes

- Single Fibre Channel loop
- Shared storage enclosure
- Two Dual HSG80 controller pairs configured in Transparent Failover Mode
- Up to 500 meters per cable segment
- Up to 168 disks
- Up to 256 LUNs, 64 available to each server with 4 active controller host ports
- In this configuration 16 connections are available, 8 in each enclosure.
- The configuration of units for both enclosures can be set identical to that described in Configuration 6. This is possible because each server will see each active controller host port as a unique target ID with a unique set of LUNs. Although LUN numbering is identical within each enclosure, when viewed by each server the LUNs on the active controller host ports in the second enclosure are assigned under different SCSI target IDs.
- For each enclosure (controller pair), rename the connection names, for example: SERVER1P1, SERVER1P2, SERVER1P1, SERVER1P2, and so forth.
- For the second controller enclosure set each controller host port ALPA to a different hexadecimal address then set on the first enclosure. Suggested settings: Controller Enclosure 1 Port 1 = 71, Port 2 = 72, Controller Enclosure 2 Port 1 = 73, Port 2 = 74.
- Set each Fibre Channel Host Bus Adapter ALPA to a unique (hexadecimal) hard address. Suggested settings: HBA1 = 01, HBA2 = 02, HBA3 = 04, HBA4 = 08.
- Set the connection name unit offset values. By default, setting the controller pairs in Transparent failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set unit offset values to 0 for Port 1 and 100 for Port 2. Use the default connection unit offset values for one of the servers and set new unit offset values for connections to the other three servers as shown below.
- Set exclusive unit access for each unit to a specific server connection name. For example: for unit D0 ENABLE = SERVER1P1; for unit D100 ENABLE = SERVER1P2.
- Suggested unit numbering and connection parameters would result in the units being distributed equally across enclosures and controller host ports as follows:

### Controller Enclosure 1

ALPA settings: Controller Host Port 1 = 71, Port 2 = 72

Server 1, Enclosure 1: Port 1 units D0–D7, Port 2 units D100–D107

Connection names, unit offset values: SERVER1P1, 0. SERVER1P2, 100

Server 2, Enclosure 1: Port 1 units D10–D17, Port 2 units D110–D117

Connection names, unit offset values: SERVER2P1, 10. SERVER2P2 110

Server 3, Enclosure 1: Port 1 units D20–D27, Port 2 units D120–D127

Connection names, unit offset values: SERVER3P1, 20. SERVER3P2, 120

Server 4, Enclosure 1: Port 1 units D30–D37, Port 2 units D130–D137

Connection names, unit offset values: SERVER4P1, 30. SERVER4P2, 130

### Controller Enclosure 2

ALPA settings: Controller Host Port 1 = 73, Port 2 = 74

Server 1, Enclosure 2: Port 1 units D0–D7, Port 2 units D100–D107

Connection names, unit offset values: SERVER1P1, 0. SERVER1P2, 100

Server 2, Enclosure 2: Port 1 units D10–D17, Port 2 units D110–D117  
 Connection names, unit offset values: SERVER2P1, 10. SERVER2P2 110

Server 3, Enclosure 2: Port 1 units D20–D27, Port 2 units D120–D127  
 Connection names, unit offset values: SERVER3P1, 20. SERVER3P2, 120

Server 4, Enclosure 2: Port 1 units D30–D37, Port 2 units D130–D137  
 Connection names, unit offset values: SERVER4P1, 30. SERVER4P2, 130

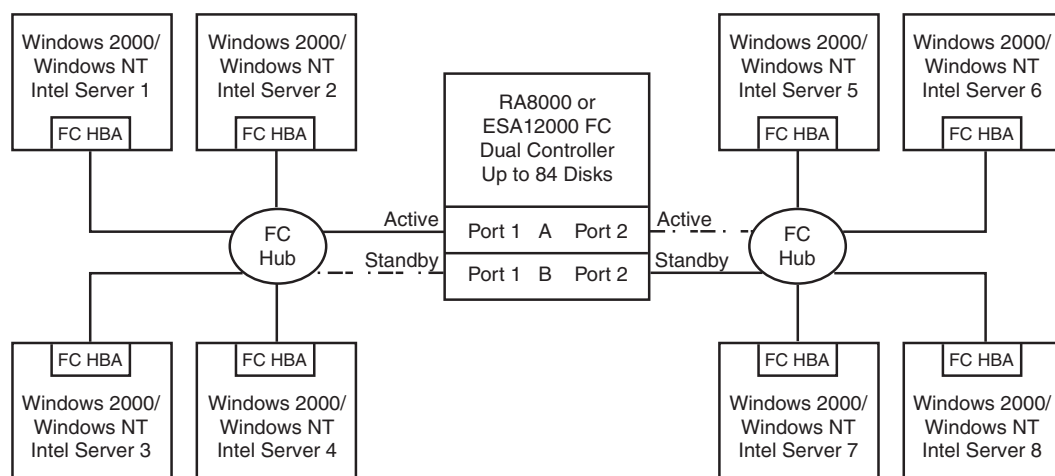
## Configuration 7 Performance Considerations

This configuration uses 2 dual controller pairs with an overall limit based on a theoretical single loop limit of 25,000 I/O/sec and 100 MB/sec data rate. The primary advantages of this configuration are the ability to connect up to four servers and two storage systems on a single Fibre Channel loop, and the added storage and LUN capacity.

This is a high connectivity configuration that can be used for moderately intensive I/O applications and intensive bandwidth applications. It is more suited for I/O applications.

## Up to Eight Servers, Dual Controller, Transparent Failover, Shared Storage Enclosure

Configuration 8 (Figure 10) builds on Configurations 5 and 6 using a dual controller pair on two Fibre Channel loops to provide storage and controller redundancy to two groups of up to four separate (non-cooperating) servers. The eight servers share the storage enclosure in that each server has exclusive access to its own set of LUNs. This is made possible by the setting of explicit “host access” at the unit level and using connection name “unit offsets” to give each server an accessible range of unit numbers. Additional levels of access control are necessary for this configuration because each group of four servers is sharing the same loop.



SHR-2258A

Figure 10: Configuration 8

## Configuration 8 Notes

- Two Fibre Channel loops
- Shared storage enclosure
- Dual HSG80 controllers configured in Transparent Failover Mode
- Up to 500 meters per cable segment

- Up to 84 disks
- Up to 128 LUNs 16 available to each server with 2 active controller host ports
- In this configuration 8 connections are available.
- Rename the connection names, for example: SERVER1P1, SERVER2P1, SERVER5P2, and so forth.
- Set the connection name unit offset values. By default, setting the controller pair in Transparent failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set unit offset values to 0 for Port 1 and 100 for Port 2. Use the default connection unit offset values for one of the servers on each loop and set new unit offset values for connections to the other six servers as shown below.
- Set exclusive unit access for each unit to a specific server connection name, for example: for unit D0 ENABLE = SERVER1P1, for unit D100 ENABLE = SERVER5P2.
- Set each Fibre Channel Host Bus Adapter ALPA to a unique hexadecimal hard address. Suggested settings: HBA1 = 01, HBA2 = 02, HBA3 = 04, HBA4 = 08.
- Suggested unit numbering and connection parameters would result in the units being distributed equally across enclosures and controller host ports as follows:
  - Server 1: Port 1 units D0–D7  
Connection name, unit offset value: SERVER1P1, 0
  - Server 2: Port 1 units D10–D17  
Connection name, unit offset value: SERVER2P1, 10
  - Server 3: Port 1 units D20–D27  
Connection name, unit offset value: SERVER3P1, 20
  - Server 4: Port 1 units D30–D37  
Connection name, unit offset value: SERVER4P1, 30
  - Server 5: Port 2 units D100–D107  
Connection name, unit offset value: SERVER5P2, 100
  - Server 6: Port 2 units D110–D117  
Connection name, unit offset value: SERVER6P2, 110
  - Server 7: Port 2 units D120–D127  
Connection name, unit offset value: SERVER7P2, 120
  - Server 8: Port 2 units D130–D137  
Connection name, unit offset value: SERVER8P2, 130

## Configuration 8 Performance Considerations

This configuration uses dual controllers with two active and two standby controller host ports. The overall limit is based on the dual controller, two active port limit of 24,000(cache)/8,200(media) I/O/sec and 154(cache)/102(media) MB/sec data rate. The primary advantage of this configuration is the ability to share the storage enclosure and connect up to eight independent servers across two Fibre Channel loops.

This is a general-purpose configuration that can be used for intensive I/O applications and very intensive bandwidth applications. It is more suited for bandwidth intensive applications however it offers adequate performance for I/O applications as well.

## Appendix A: Examples of HA Configurations

This appendix provides examples of High Availability configurations, for the following operating systems:

- “[HSun Solaris](#)” on page 25
- “[Tru64 UNIX](#)” on page 29

### HSun Solaris

This section lists examples of the most common Sun Solaris Enterprise Modular Storage RAID Array Fibre Channel high availability (HA) configurations.

---

**Note:** These examples apply to JNI HBAs in transparent failover only.

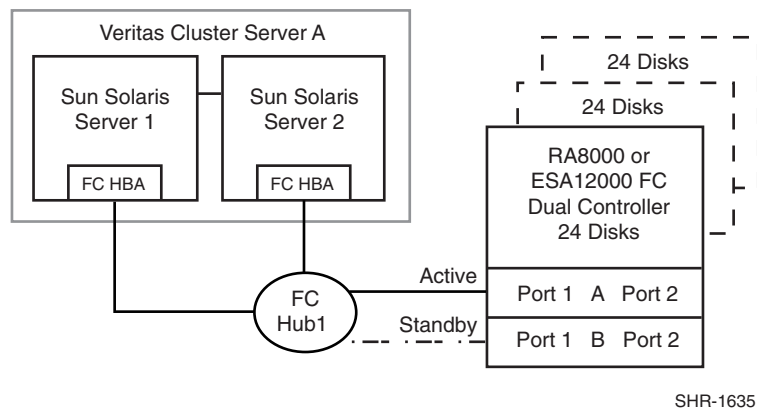
---

**Table 3: Typical FC-AL Sun Solaris configurations**

| Configuration | Description                                                                              |
|---------------|------------------------------------------------------------------------------------------|
| 1             | Two Servers, Veritas Cluster Server, Transparent Failover                                |
| 2             | Four Servers, Veritas Cluster Server, Transparent Failover, One Shared Storage Enclosure |

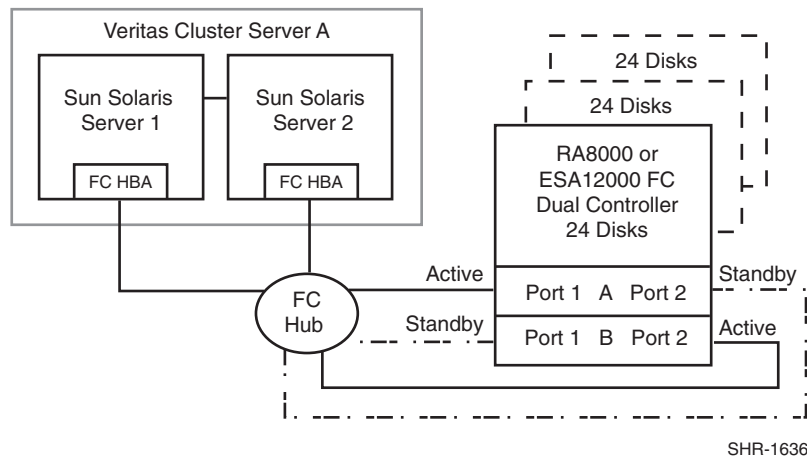
### HA Configuration 1—Two Servers, Veritas Cluster Server, Transparent Failover

HA Configuration 1 (Figure 11) provides dual redundant controllers configured in Transparent Failover mode. The configuration consists of a single Enterprise Modular Storage RAID Array storage enclosure with two HSG80 array controllers connected to two servers running Veritas Cluster Server Application software. In normal operation Controller A provides the active path for all storage sets to the server pair through Controller A, Port 1. A second controller, Controller B, is a hot standby. In the event of a failure in Controller A, Controller B will automatically become active. All units being accessed through Port 1 of Controller A will become accessible through Port 1 of Controller B. In the event of a server failure, Veritas Cluster Server will transfer access to units through the surviving server. In the initial configuration a single controller host port (Port 1) is active providing up to 64 LUNs across up to 24 disks. An additional 48 disks can be added using two expansion enclosures.



**Figure 11: HA configuration 2**

With the addition of two Fibre Channel cables, Controller B, can become an active controller to increase performance and double LUN capacity. Two additional Fibre Channel cables, one connected to Controller A Port 2, and one connected to Controller B Port 2, result in the configuration shown in Figure 12. This configuration provides full controller redundancy in the event that Controller A or Controller B fails. In either failover scenario the surviving controller will transition a standby port to active providing access to all units in the Veritas Cluster Server pair.



**Figure 12: HA configuration 2 with increased performance and doubled LUN capacity**

## HA Configuration 1 Notes

**Figure 11** shows the following configurations:

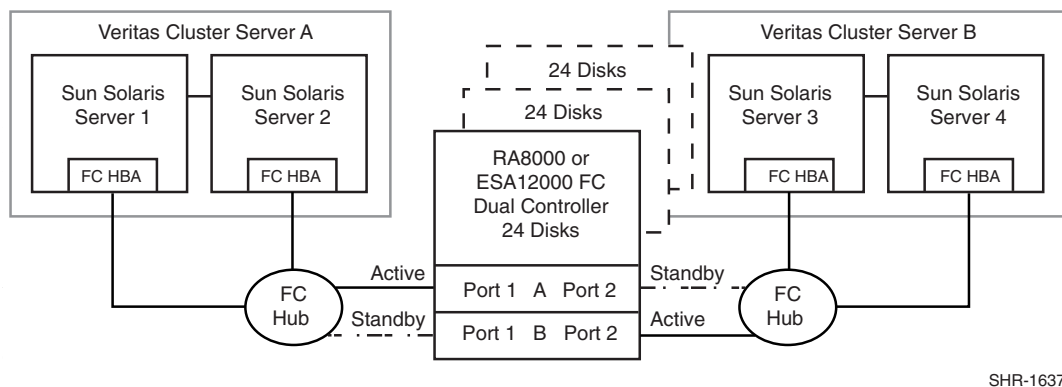
- Single Fibre Channel loop
- Dual HSG80 controllers configured in Transparent Failover Mode
- Enterprise Modular Storage RAID Array HSG80 Solution Software V8.8 for Sun Solaris installed
- Veritas Cluster Server application software installed
- Up to 500 meters per cable segment

- Up to 72 disks with 2 optional expansion cabinets
- Up to 64 LUNs with 1 active controller host port
- Suggested controller unit number assignment: Port 1 units D0–D63. Two (2) logical connections are available.
- Rename the connection names, that is, SERVER1P1, SERVER1P2.
- Run `/opt/steam/bin/config.sh` to account for the required LUNs.

**Figure 12** shows the following configurations:

- Single Fibre Channel loop
- Dual HSG80 controllers configured in Transparent Failover Mode
- Enterprise Modular Storage RAID Array HSG80 Solution Software V8.8 for Sun Solaris installed
- Veritas Cluster Server application software installed
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion cabinets
- Up to 128 LUNs with 2 active controller host ports. Suggested controller unit number assignment: Port 1 units D0–D63, Port 2 units D100–D163. 4 logical connections are available.
- Utilization of controller host Port 2 requires two additional Fibre Channel cables
- Setting the controller pair in Transparent Failover mode will, by default automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set unit offset values to 0 for Port 1 and 100 for Port 2.
- Rename the connection names, that is, SERVER1P1, SERVER1P2, SERVER2P1, SERVER2P2.
- Run `/opt/steam/bin/config.sh` to account for the required LUNs.

## HA Configuration 2—Four Servers, Veritas Cluster Server, Transparent Failover, Shared Storage Enclosure



**Figure 13: HA configuration 3**

## HA Configuration 2 Notes

- Enterprise Modular Storage RAID Array HSG80 Solution Software V8.8 for Sun Solaris installed

- Veritas Cluster Server application software for two server pairs installed
- Shared storage enclosure
- Two Fibre Channel loops
- Dual HSG80 controllers configured in Transparent Failover Mode
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion enclosures
- Up to 128 LUNs total/64 per server pair with 2 active controller host ports
- Suggested controller unit number assignment:  
Server pair A, Controller A Port 1 units D0–D63  
Server pair B, Controller B Port 2 units D100–D163
- By default, setting the controller pair in Transparent Failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set the unit offset values to 0 for Port 1 and 100 for Port 2.
- In this configuration 4 logical connections are available.
- Rename the connection names, that is, SERVER1P1, SERVER2P1, SERVER3P2, SERVER4P2.
- Run `/opt/steam/bin/config.sh` to account for the required LUNs.

## HA Application Options for Sun Solaris

This section discusses the following High Availability application options:

- Secure Path V 2.1 or 5.0A for Sun Solaris
- Veritas Cluster Server V1.0.1 for Solaris V2.8

### Secure Path V 2.1 or 5.0A for Sun Solaris

HP StorageWorks Secure Path is a high availability software product providing continuous data access for Enterprise Modular Storage RAID Array FC products configured on Sun Solaris. Redundant hardware, advanced RAID technology and automated failover capability are used to enhance data availability. Secure Path effectively eliminates controllers, interconnect hardware and host bus adapters as single points of failure in the storage system.

The key is the capability of Enterprise Modular Storage RAID Array FC dual HSG80 controllers to operate in the active/active Multiple-bus failover mode. This failover mode allows each controller to be configured on its own bus and to process I/O independently under normal operation. Available storage units are “preferred” to one or the other of the two controllers which determines which controller path is used for access at system boot time. During runtime, storage units may be moved between paths at anytime using the Secure Path Management Tool.

Controllers in Multiple-bus failover mode monitor each other and automatically failover storage units from the failed member of a controller pair. The software detects the failure of I/O operations to complete on a failed path and automatically re-routes all traffic to the surviving path. Controller and path failover is completed seamlessly, without process disruption or data loss.

The Secure Path management utility provides continuous monitoring capability and identifies failed paths and failed-over storage units. To facilitate static load balancing, storage units can be moved between paths using the Management Tool.

The integration of Secure Path and RAID Array Fibre Channel technology provides the maximum level of fault-tolerance, data availability, and performance required for mission-critical environments.

## Veritas Cluster Server V1.0.1 for Solaris V2.8

Veritas Cluster Server is a high-availability cluster solution that provides proactive management of application services. The Veritas Cluster Server Java-based management GUI provides a single point of management for the entire cluster configuration. Veritas Cluster Server:

- Is architecture-independent supporting up to 32 servers and compatible with single server, parallel and distributed applications.
- Supports cascading and multi-directional application failover and application services can be manually migrated to alternate servers for maintenance purposes.
- Provides a comprehensive availability management solution designed to minimize both planned and unplanned down time.
- Can accommodate new and existing Sun and third-party hardware and can be easily adapted to meet site-specific requirements.
- Minimizes deployment time with features such as a self-replicating single configuration file per configuration, installation wizards and templates, auto-discovery of new cluster resources, and off-the-shelf agents to fault manage the industry's most popular applications.

## Tru64 UNIX

This section lists examples of the most common Tru64 UNIX Enterprise Modular Storage RAID Array Fibre Channel high availability (HA) configurations.

**Table 4: Typical FC-AL Tru64 UNIX configurations**

| Configuration | Description                             |
|---------------|-----------------------------------------|
| 1             | One Server, one HSG80 pair              |
| 2             | Two Servers, one HSG80 pair             |
| 3             | Two Servers, two HSG80 pairs            |
| 4             | Two Servers, two HSG80 pairs, dual HBAs |

**Note:** All configurations have one or more HSG80 Storage Systems with dual-controllers bound in Multiple-bus Failover Mode.

## HA Configuration 1—One Server, One HSG80 Pair

Configuration 1 (Figure 14) represents an entry-level Enterprise Modular Storage RAID Array configuration that can be expanded to support additional storage capacity or performance needs as required. The configuration consists of a single Enterprise Modular Storage RAID Array enclosure with two HSG80 array controllers configured in Multiple-Bus Failover mode. The initial configuration supports up to 24 disks. Support for an additional 48 disks can be added using two expansion enclosures.

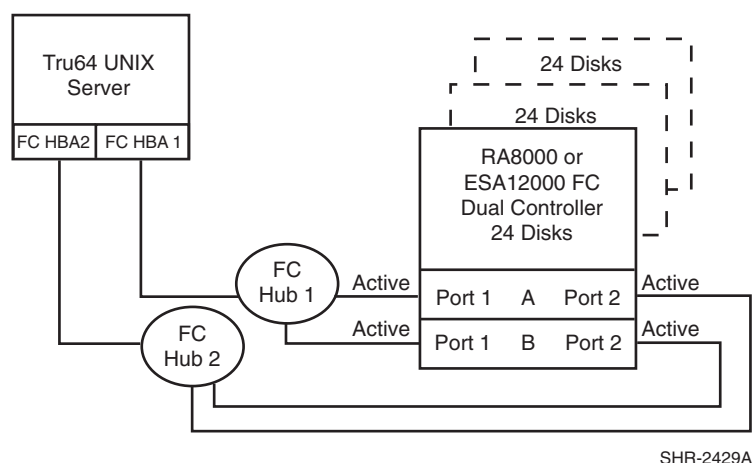


Figure 14: Configuration 1

### HA Configuration 1 Notes

- Two Fibre Channel loops
- Enterprise Modular Storage RAID Array HSG80 Solution Software V8.8 for Tru64 UNIX installed
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion cabinets
- Set the Unit Preferred Path. Use the Preferred Path unit parameter to assign units to specific controllers. Units should be distributed equally across controllers.
- Rename the connection names, that is, SERV1P1A, SERV1P1B.
- Dual HBAs set to loop mode

### HA Configuration 2—Two Servers, One HSG80 Pair

Configuration 2 (Figure 15) provides dual redundant controllers configured in multiple-bus failover node. The configuration consists of a single Enterprise Modular Storage RAID Array storage enclosure with two HSG80 array controllers connected to two servers in a TruCluster configuration.

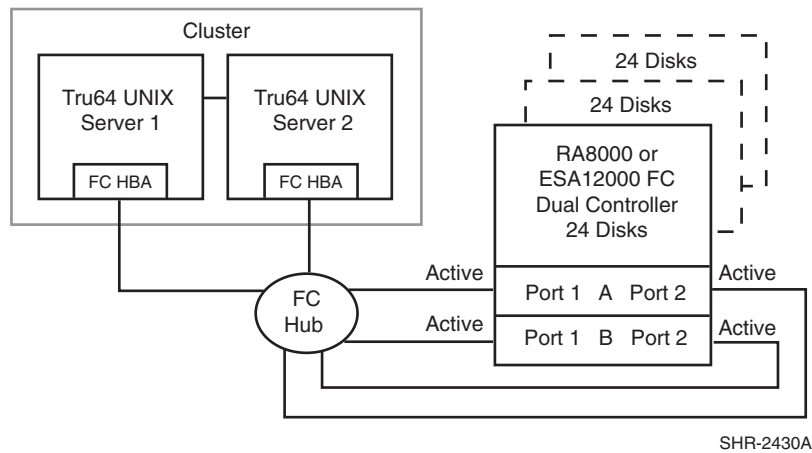


Figure 15: Configuration 2

### HA Configuration 2 Notes

- Single Fibre Channel loop
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Enterprise Modular Storage RAID Array HSG80 Solution Software V8.8 for Tru64 UNIX
- TruCluster software installed
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion cabinets
- Rename the connection names, that is, SERVER1P1, SERVER1P2.

### HA Configuration 3—Two Servers, Two HSG80 Pairs

Configuration 3 (Figure 16) demonstrates the use of two HSG80 storage systems connected to a two node TruCluster configuration using Fibre Channel Arbitrated Loop (FC-AL) using two seven port hubs.

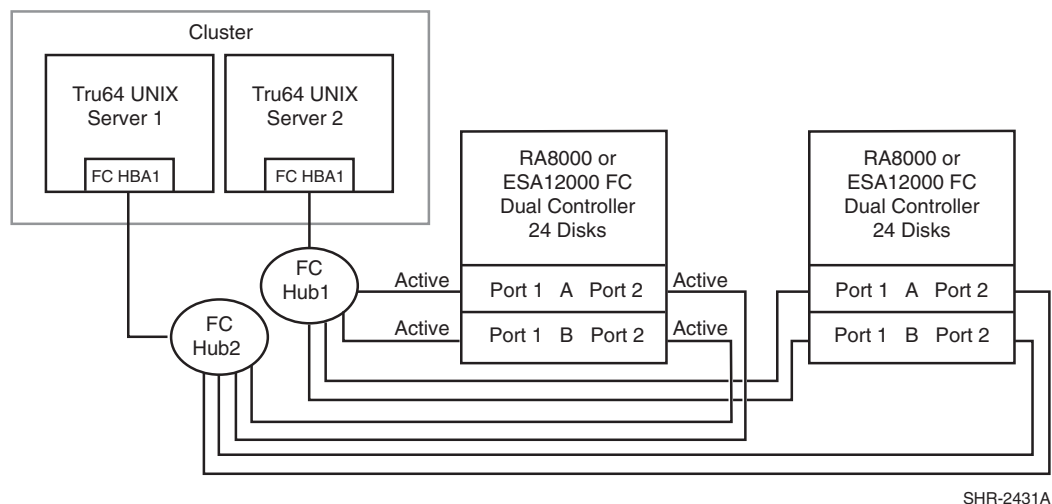


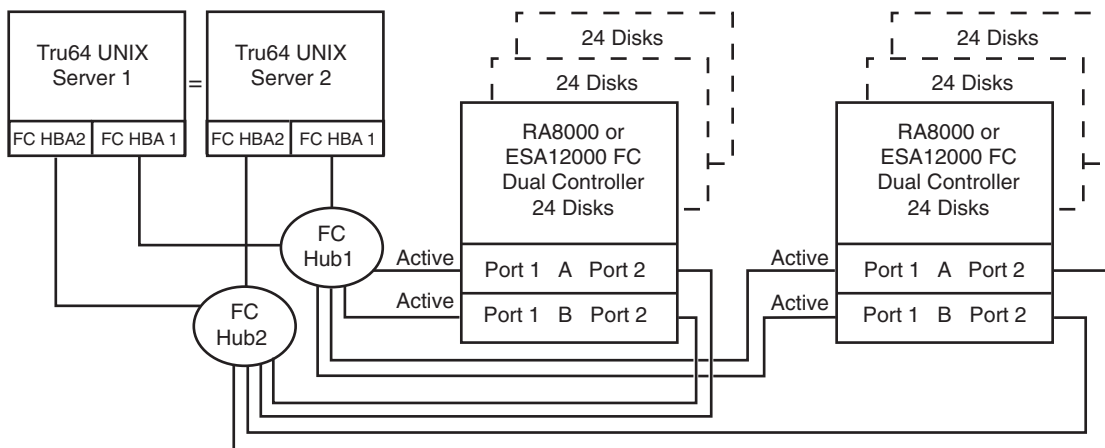
Figure 16: Configuration 3

### HA Configuration 3 Notes

- Two Fibre Channel loops
- Enterprise Modular Storage RAID Array HSG80 Solution Software V8.8 for Tru64 UNIX installed
- TruCluster configuration
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 72 disks with 2 optional expansion cabinets per HSG80 pair
- Set the Unit Preferred Path. Use the Preferred Path unit parameter to assign units to specific controllers. Units should be distributed equally across controllers.
- Rename the connection names, that is, SERV1P1A, SERV1P1B, SERV2P1A, SERV2P1B.
- One HBA per host set to loop mode
- One memory channel cluster connection

### HA Configuration 4—Two Servers, Two HSG80 Pairs, Dual HBAs

Configuration 4 (Figure 17) builds on configurations 3 by using dual HBAs in the hosts, dual memory channel cluster connections and dual FC-AL hubs in a TruCluster configuration



SHR-2432A

**Figure 17: Configuration 4**

### HA Configuration 4 Notes

- Two Fibre Channel loops
- Two shared storage enclosures
- Enterprise Modular Storage RAID Array HSG80 Solution Software V8.8 for Tru64 UNIX installed
- TruCluster configuration
- Two HSG80 controller pairs configured in Multiple-Bus Failover mode
- Up to 500 meters per cable segment
- Up to 144 disks with 4 optional expansion cabinets

- For each storage enclosure (controller pair), set the Unit Preferred Path. Use the Preferred Path unit parameter to distribute units equally across controllers/ports.

For example:

Prefer units D0–D15 to Controller A

Prefer units D16–D31 to Controller B

Prefer units D32–D47 to Controller A

Prefer units D48–D63 to Controller B

Prefer units D64–D79 to Controller A

Prefer units D80–D95 to Controller B

Prefer units D96–D111 to Controller A

Prefer units D112–D127 to Controller B

- For each storage enclosure (controller pair), rename the connection names, that is, SRV1A1P1A, SRV1A2P1B, SRV2A1P1A, SRV2A2P1B, SRV3A1P1A, SRV3A2P1B, SRV4A1P1A, SRV4A4P1B.
- For the second enclosure set each controller host port ALPA to a different address than set on the first enclosure. Suggested settings: Enclosure 1 Port 1 = 71, Port 2 = 72. Enclosure 2 Port 1 = 73, Port 2 = 74, etc.
- Two HBAs per host, set to loop mode
- Two memory channel cluster connections

## Appendix B: Microsoft Cluster Server (MSCS)

A Windows NT/Windows 2000 MSCS cluster enables two servers to share an Enterprise Modular Storage RAID Array Fibre Channel system through a Fibre Channel bus. If a server failure should occur, the storage I/O is re-routed through to the functioning server. This process, called cluster failover, requires no resource downtime ensuring the high availability of data.

The Enterprise Modular Storage RAID Array Fibre Channel systems are supported in four Windows NT/Windows 2000 MSCS cluster configurations. All of the cluster configurations provide full cluster failover capabilities through a Fibre Channel bus connected to both cluster servers.

In addition to cluster failover, the RAID array controllers can be configured in transparent failover mode to protect against the unlikely event of a single controller failure. This feature eliminates controllers as single points of failure and is invoked without the need for server intervention.

For the highest availability, two hardware paths between the cluster servers and the Enterprise Modular Storage RAID Array Fibre Channel system can be configured using Secure Path for Windows NT/Windows 2000. This configuration provides two separate physical paths between the servers and the storage.

### Secure Path for Windows NT/Windows 2000

Secure Path is a high availability software product providing continuous data access for Enterprise Modular Storage RAID Array Fibre Channel products configured on Windows NT/Windows 2000 platforms. Redundant hardware, advanced RAID technology and automated failover capability are used to enhance fault tolerance and availability. Secure Path effectively eliminates controllers, interconnect hardware and host bus adapters as single points of failure in the storage system.

Key to Secure Path's functionality is the capability of Enterprise Modular Storage RAID Array Fibre Channel dual HSG80 controllers to operate in the active/active Multiple-Bus failover mode. This failover mode allows each controller to be configured on its own bus and to process I/O independently under normal operation. Available storage units are "preferred" to one or the other of the two controllers which determines which controller path is used for access at system boot time. During runtime, storage units may be moved between paths at anytime through use of the management utility.

Controllers in Multiple-Bus failover mode monitor each other and automatically failover storage units from the failed member of a controller pair. The Secure Path software detects the failure of I/O operations to complete on a failed path and automatically re-routes all traffic to the surviving path. Controller and path failover is completed seamlessly, without process disruption or data loss.

The Secure Path management utility provides continuous monitoring capability and identifies failed paths and failed-over storage units. To facilitate static load balancing, storage units can be moved between paths using simple "drag-and-drop" operations.

The integration of Secure Path, Windows NT/Windows 2000 Clustering, and HP StorageWorks RAID Array Fibre Channel technology provides the maximum level of fault-tolerance, data availability, and performance required for mission-critical environments.

## Performance Considerations

The performance of an application on a system that includes Enterprise Modular Storage RAID Array Fibre Channel can be limited by many different components of the system. Some of the possible component limitations include the host CPU(s), memory size, the host bus adapter(s) (HBA), the Fibre Channel bus, the RAID controller, or the specific configuration of disks used behind the controller. The limiting factor can move to any of these components depending on the workload. Identifying the limits will assist in determining the best configuration for a given application.

Table 5 lists the upper limit performance specifications for the components of the Enterprise Modular Storage RAID Array Fibre Channel systems based on testing using standard storage performance tests and methodologies. These numbers should be used to compare component level performance as a means to determine the best configuration from a performance perspective. User application tests may not necessarily reach these levels of performance as applications may perform additional levels of processing for each I/O. The controller specifications listed show both cache (no disk access) and media (with disk access) limitations.

**Table 5: Performance maximums of FC-AL components**

| Transfer Size                                      | IO/sec (small transfer sizes, random access) |                             | MB/sec (large transfer sizes, sequential access) |                       |
|----------------------------------------------------|----------------------------------------------|-----------------------------|--------------------------------------------------|-----------------------|
|                                                    | Read                                         | Write                       | Read                                             | Write                 |
| Fibre Channel Host Bus Adapter - KGPSA-BC (LP7000) | 15,500                                       | 14,250                      | 86                                               | 51                    |
| Fibre Channel Hub                                  | 25,000                                       | 25,000                      | 100                                              | 100                   |
| Single HSG80 Controller (1 Active Port)            | 12,000 Cache<br>4,100 Media                  | 9,000 Cache<br>4,000 Media  | 77 Cache<br>54 Media                             | 50 Cache<br>44 Media  |
| Single HSG80 Controller (2 Active Ports)           | 12,000 Cache<br>4,100 Media                  | 9,000 Cache<br>4,000 Media  | 98 Cache<br>54 Media                             | 100 Cache<br>47 Media |
| Dual HSG80 Controllers (2 Active/2 Standby Ports)  | 24,000 Cache<br>8,200 Media                  | 18,000 Cache<br>8,000 Media | 154 Cache<br>102 Media                           | 101 Cache<br>88 Media |
| Dual HSG80 Controllers (4 Active Ports)            | 24,000 Cache<br>8,200 Media                  | 18,000 Cache<br>8,000 Media | 195 Cache<br>102 Media                           | 178 Cache<br>88 Media |

**Note:** Fibre Channel Hub performance limits are theoretical. Actual measured performance is lower due to limits unrelated to the hub.

To further aid in evaluating the performance aspects of specific configurations, additional information is included within each configuration section. The configurations are rated based on I/O performance (I/Os per second)—typical of small transfer applications such as databases and mail, and bandwidth performance (MBs per second)—typical of large transfer applications such as video and graphics. Note that other factors, such as connectivity needs, may require trade-offs be made such that performance is a secondary consideration.

## MSCS HA Configuration Descriptions

Table 6 lists the most common Enterprise Modular Storage RAID Array Fibre Channel Windows NT/Windows 2000 high availability configurations.

**Table 6: Common Enterprise Modular Storage RAID Array FC-AL Windows NT/Windows 2000HA configurations**

| High Availability Configuration # | Description                                                                                                                 |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| 1                                 | One Server, Secure Path, Dual Controller, Multiple-Bus Failover                                                             |
| 2                                 | Two Servers, MSCS, Dual Controller, Transparent Failover                                                                    |
| 3                                 | Four Servers, MSCS, Dual Controller, Transparent Failover, Two Independent Clusters, Shared Storage Enclosure               |
| 4                                 | Two Servers, MSCS, Secure Path, Dual Controller, Multiple-Bus Failover                                                      |
| 5                                 | Two Servers, MSCS, Secure Path, Four Dual Controller, Pairs Multiple-Bus Failover                                           |
| 6                                 | Four Servers, MSCS, Secure Path, Dual Controller, Multiple-Bus Failover, Two Independent Clusters, Shared Storage Enclosure |
| 7                                 | Up to Four Servers, Secure Path, Dual Controller, Multiple-Bus Failover, Shared Storage Enclosure                           |
| 8                                 | Up to Four Servers, Secure Path, Two Dual Controller Pairs, Multiple-Bus Failover, Shared Storage Enclosure                 |
| 9                                 | Up to Eight Servers, Secure Path, Two Dual Controller Pairs, Multiple-Bus Failover, Shared Storage Enclosure                |

### HA Configuration 1—One Server, Secure Path, Dual Controller, Multiple-bus Failover

HA Configuration 1 (Figure 18) represents an entry-level Enterprise Modular Storage RAID Array high availability configuration that can be expanded to support additional storage capacity or performance needs as required. The configuration consists of a single Enterprise Modular Storage RAID Array enclosure with two HSG80 array controllers configured in Multiple-Bus Failover mode. The configuration uses two separate paths (two Fibre Channel loops) to the storage. In the event of a failure of any component within the access path—host bus adapter, cables, hub, or controller host port interface, all LUNs on the failing path will become accessible through the alternate path. The initial configuration provides up to 84 disks.

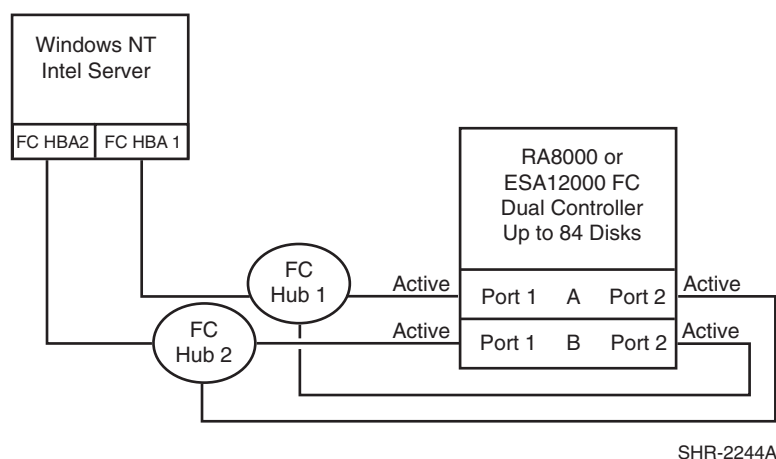


Figure 18: HA configuration 1

### HA Configuration 1 Notes

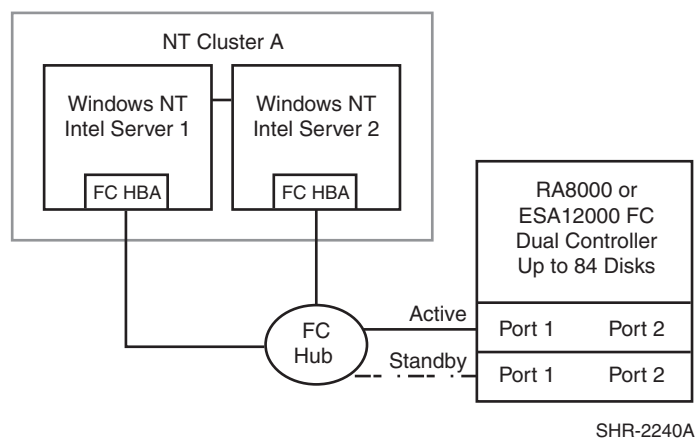
- Two Fibre Channel loops
- Uses Secure Path for Windows NT/Windows 2000 (minimum revision 3.0). Dynamic load distribution is available in this configuration when configured for maximum controller port paths.
- One instance of Secure Path Manager can control all paths
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 84 disks
- Depending on your specific application needs, configure either for maximum LUNs or for maximum controller port PATH accessibility
  - For Maximum LUN Count—Up to 16 LUNs with 4 active controller host ports. Suggested distinct controller port unit number and offset value assignment: Port 1 units D0–D7, unit offset = 0, Port 2 units D100–D107, unit offset = 100. Use the Preferred Path unit parameter to assign units to specific controllers for static load balancing. Prefer units D0–D3, D100–D103 to Controller A, prefer units D4–D7, D104–D107 to Controller B.
  - For Maximum Controller Port PATH Accessibility—Up to 8 LUNs with 4 active controller host ports and dynamic load distribution between two ports on the same controller. Suggested controller unit number and offset value assignment: All controller port connections use unit offset = 0 and have access to units D0–D7. Use the Preferred Path unit parameter to assign units to specific controllers. Units should be distributed equally across controllers for static load balancing. Prefer units D0–D3 to Controller A, prefer units D4–D7 to Controller B. Enable dynamic load distribution.
- In this configuration 4 logical connections are available.
- Rename the connection names, for example: SERVA1P1A, SERVA1P2B, SERVA2P1B, SERVA2P2A.
- Set the same ALPA for each Fibre Channel host bus adapter. Suggested settings: HBA1 = 01, HBA2 = 01.

## HA Configuration 1 Performance Considerations

This configuration uses dual controllers with four active controller host ports. The overall limit is based on the two active host bus adapter limit of 31,000 I/O/sec and 172 MB/sec data rate. The primary advantage of this configuration is the ability to provide redundant independent paths to the storage. This is a general-purpose configuration that can be used for intensive I/O applications and very intensive bandwidth applications.

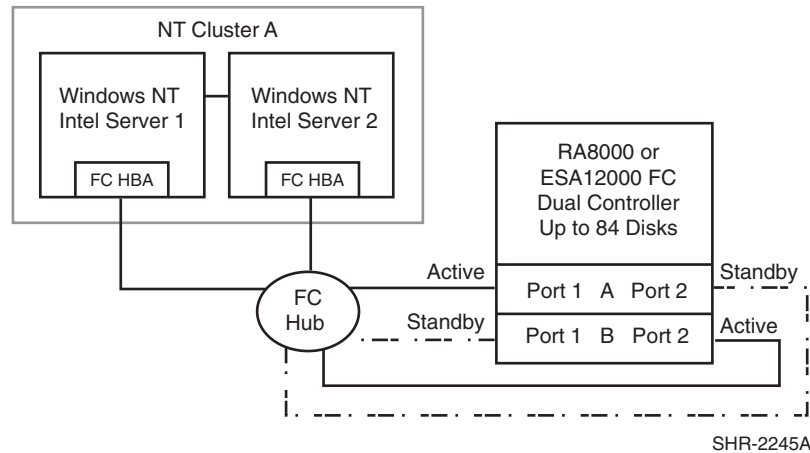
## HA Configuration 2—Two Servers, MSCS, Dual Controller, Transparent Failover

HA Configuration 2 (Figure 19) provides dual redundant controllers configured in Transparent Failover mode. The configuration consists of a single Enterprise Modular Storage RAID Array enclosure with two HSG80 array controllers connected to two servers running MSCS software. In normal operation Controller A provides the active path for all storagesets to the cluster through Controller A, Port 1. A second controller, Controller B, is a hot standby. In the event of a failure in Controller A, Controller B will automatically become active. All units being accessed through Port 1 of Controller A will become accessible through Port 1 of Controller B. In the event of a server failure, cluster failover will be invoked to provide access to units through the surviving server. In the initial configuration a single controller host port (Port 1) is active providing up to 8 LUNs across up to 84 disks. An additional 48 disks can be added using two expansion enclosures.



**Figure 19: HA configuration 2**

With the addition of two Fibre Channel cables, the second controller, Controller B, can become an active controller to increase performance and double LUN capacity. Two additional Fibre Channel cables, one connected to Controller A Port 2, and one connected to Controller B Port 2, result in the configuration shown in Figure 20. This configuration provides full controller redundancy in the event that Controller A or Controller B fails. In either failover scenario the surviving controller will transition a standby port to active providing access to all units in the cluster.



**Figure 20: HA configuration 2 with increased performance and doubled LUN capacity**

### HA Configuration 2 Notes

- Single Fibre Channel loop
- Dual HSG80 controllers configured in Transparent Failover Mode
- MSCS
- Up to 500 meters per cable segment
- Up to 84 disks
- Up to 8 LUNs with 1 active controller host port (Figure 19). Suggested controller unit number assignment: Port 1 units D0–D7. In this configuration 2 logical connections are available.
- Up to 16 LUNs with 2 active controller host ports (Figure 20). Suggested controller unit number assignment: Port 1 units D0–D7, Port 2 units D100–D107. In this configuration, 4 logical connections are available.
- Utilization of Controller A Host Port 2, and Controller B Host Port 2, requires two additional Fibre Channel cables.
- By default, setting the controller pair in Transparent Failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set unit offset values to 0 for Port 1 and 100 for Port 2.
- In the Figure 19 configuration, two logical connections are available; in the Figure 20 configuration, four logical connections are available, rename the connection names, for example: SERVER1P1, SERVER1P2, SERVER2P1, SERVER2P2.
- Set each Fibre Channel host bus adapter ALPA to a unique hexadecimal hard address. Suggested settings: Server 1 HBA = 01, Server 2 HBA = 02.

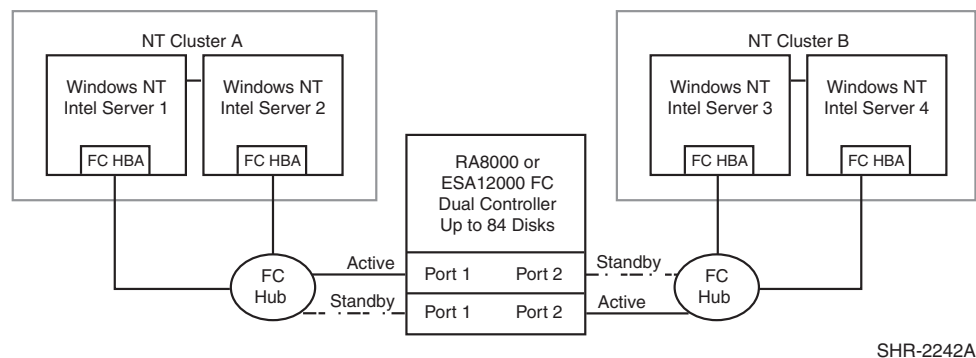
## HA Configuration 2 Performance Considerations

The configuration in Figure 20 uses a single active controller host port, resulting in a throughput limit of 12,000(cache)/4,100(media) I/O/sec, and a data rate limit of 77(cache)/54(media) MB/sec. Utilizing the second controller host port as shown in Figure 21, results in a performance increase up the dual controller two active port limit of 24,000 I/O/sec and a theoretical single loop of 100 MB/sec data rate.

This is a general-purpose configuration that can be used for typical I/O applications and typical bandwidth applications. Using the second controller will increase performance to allow for intensive I/O applications and moderately intensive bandwidth applications.

## HA Configuration 3—Four Servers, MSCS, Dual Controller, Transparent Failover, Two Independent Clusters, Shared Storage Enclosure

This dual-controller configuration (Figure 21) uses the two pairs of controller host ports to provide storage for a second, independent Windows NT/Windows 2000 Cluster. Each Windows NT/Windows 2000 Cluster can be configured with up to 8 LUNs. The two clusters share the storage enclosure in that each cluster has exclusive access to its own LUNs through the use of mutually exclusive LUN numbering. The controllers are configured in Transparent Failover mode providing controller redundancy for both clusters. In the event of a controller failover, the surviving controller will continue to provide full access to units in both clusters. In the event of a server failure, cluster failover will be invoked to provide access to units through the surviving server. In this configuration two active controller ports provide up to 16 LUNs across up to 84 disks. An additional 48 disks can be added using two expansion enclosures to increase storage capacity.



**Figure 21: HA configuration 3**

## HA Configuration 3 Notes

- Two MSCS clusters
- Shared storage enclosure
- Two Fibre Channel loops
- Dual HSG80 controllers configured in Transparent Failover Mode
- Up to 500 meters per cable segment
- Up to 84 disks with 2 optional expansion enclosures
- Up to 16 LUNs total/8 per cluster with 2 active controller host ports. Suggested controller unit number assignment: Cluster A, Controller A Port 1 units D0–D7. Cluster B, Controller B Port 2 units D100–D107.

- By default, setting the controller pair in Transparent Failover mode will automatically configure Port 1 and Port 2 of both controllers to the Active and Standby state indicated, and set the unit offset values to 0 for Port 1 and 100 for Port 2.
- In this configuration 4 logical connections are available, rename the connection names, for example: SERVER1P1, SERVER2P1, SERVER3P2, SERVER4P2.
- Set exclusive access for each unit to specific server connection names. For example: for unit D0 ENABLE = SERVER1P1, SERVER2P1; for unit D100 ENABLE = SERVER3P2, SERVER4P2.
- For each loop, set each Fibre Channel host bus adapter ALPA to a unique hexadecimal hard address. Suggested settings: Server 1 HBA = 01, Server 2 HBA = 02.

### HA Configuration 3 Performance Considerations

This configuration uses Dual Controllers with two active and two standby controller host ports. The overall limit is based on the dual controller, two active port limit of 24,000(cache)/8,200(media) I/O/sec and 154(cache)/102(media) MB/sec data rate. The primary advantage of this configuration is the ability to share the storage enclosure between two independent clusters without any performance degradation.

This is a general-purpose configuration that can be used for intensive I/O applications and very intensive bandwidth applications.

### HA Configuration 4—Two Servers, MSCS, Secure Path, Dual Controller, Multiple-bus Failover

This dual-controller configuration (Figure 22) offers four active controller host ports.

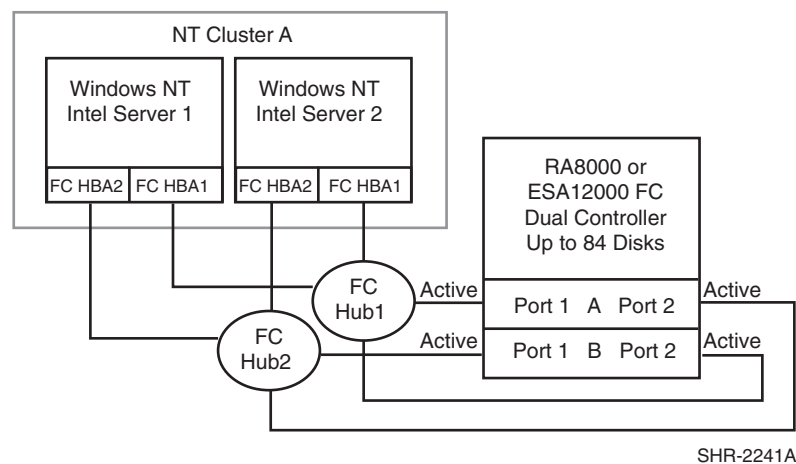


Figure 22: HA configuration 4

### HA Configuration 4 Notes

- Two Fibre Channel loops
- Uses Secure Path for Windows NT/Windows 2000 (minimum revision 3.0). Dynamic load distribution is not available in this configuration.
- One instance of Secure Path Manager can control all paths.
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 84 disks

- Depending on your specific application needs, configure either for maximum LUNs or for maximum controller port paths.
  - For Maximum LUN Count—Up to 16 LUNs with 4 active controller host ports. Suggested distinct controller port unit number and offset value assignment: Port 1 units D0–D7, unit offset = 0, Port 2 units D100–D107, unit offset = 100. Use the Preferred Path unit parameter to assign units to specific controllers for static load balancing. Prefer units D0–D3, D100–D103 to Controller A, prefer units D4–D7, D104–D107 to Controller B.
  - For Maximum Controller Port PATH Accessibility—Up to 8 LUNs with 4 active controller host ports. Suggested controller unit number and offset value assignment: All controller port connections use unit offset = 0 and have access to units D0–D7. Use the Preferred Path unit parameter to assign units to specific controllers. Units should be distributed equally across controllers for static load balancing. Prefer units D0–D3 to Controller A, prefer units D4–D7 to Controller B.
- In this configuration 8 logical connections are available, rename the connection names, for example: SRV1A1P1A, SRV1A2P1B, SRV1A1P2B, SRV1A2P2A, and so forth.
- In each server set the ALPA for each Fibre Channel host bus adapter to the same hexadecimal hard address, but unique on the loop. Suggested settings: Server 1 HBA1 = 01, HBA2 = 01, Server 2 HBA1 = 02, HBA2 = 02.

## HA Configuration 4 Performance Considerations

This configuration uses dual controllers with four active controller host ports. The overall limit is based on the dual controller, two active port limit of 24,000(cache)/8,200(media) I/O/sec and 195(cache)/102(media) MB/sec data rate. The primary advantage of this configuration is the ability to provide redundant independent paths to the storage and redundant servers.

This is a general-purpose configuration that can be used for intensive I/O applications and extremely intensive bandwidth applications.

## HA Configuration 5—Two Servers, MSCS, Secure Path, Four Dual Controller Pairs, Multiple-bus Failover

Configuration 5 (Figure 23) builds on Configuration 4 using four Fibre Channel host bus adapters in each cluster server connected to four dual controller pairs on four loops to provide storage path and controller redundancy with high storage capacity. The configuration uses two separate paths to each storage enclosure from each server in the cluster. In the event of a failure of any component within the access path—host bus adapter, cables, hub, or controller host port interface, all LUNs on the failing path will become accessible through the alternate path. In the event of a server failure, cluster failover will provide access to all storage from the surviving server.

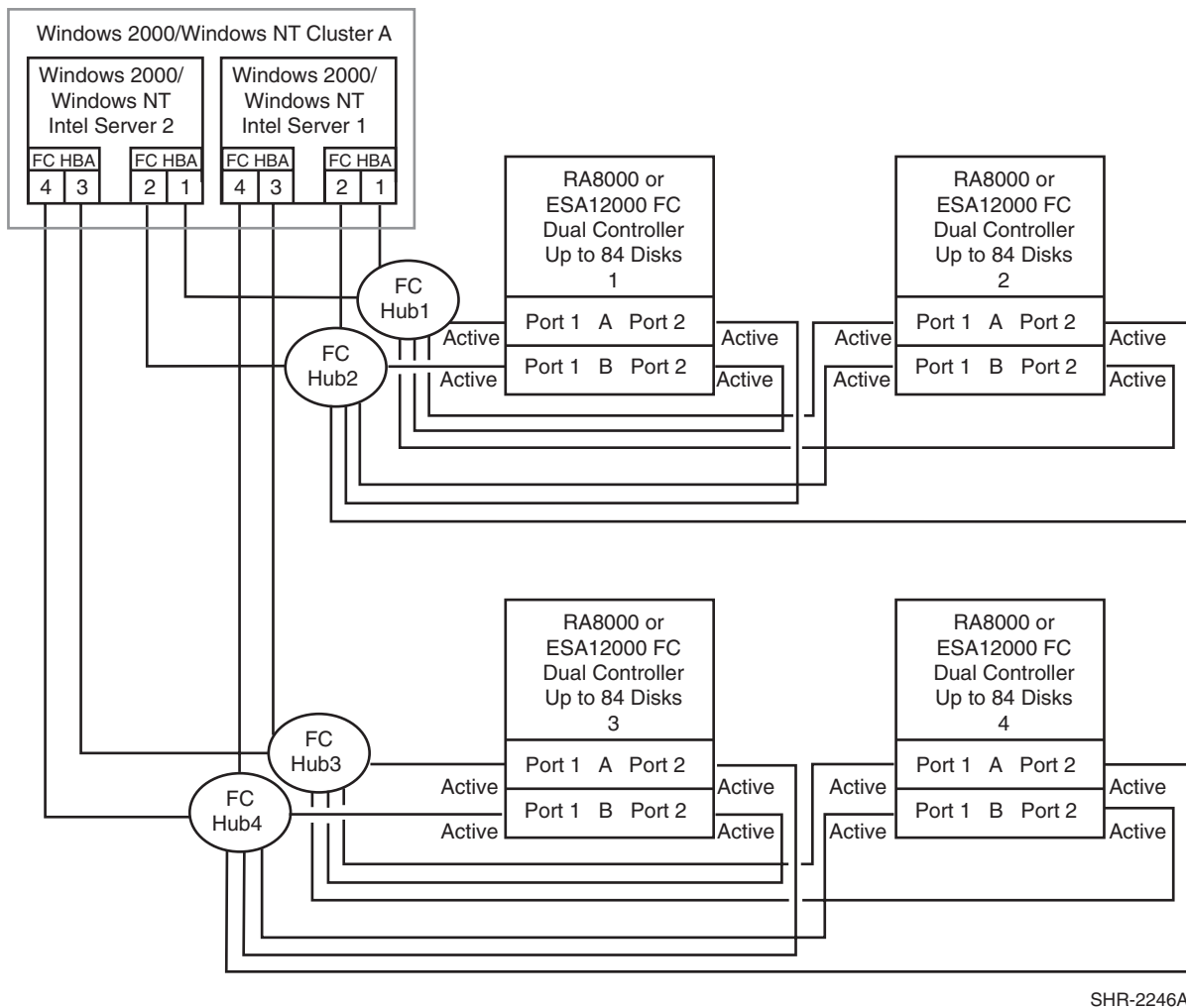


Figure 23: HA configuration 5

### HA Configuration 5 Notes

- Four Fibre Channel loops
- Uses Secure Path for Windows NT/Windows 2000 (minimum revision 3.0). Dynamic load distribution is not available in this configuration.
- One instance of Secure Path Manager can control all paths.
- Four Dual HSG80 controller pairs configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 336 disks
- In this configuration 32 logical connections are available, 8 in each enclosure. For each enclosure (controller pair), rename the connection names as shown below
- In each server set the ALPA for each Fibre Channel host bus adapter to the same hexadecimal hard address, but unique on the loop. Suggested settings: Server 1 HBA1 = 01, HBA2 = 01, HBA3 = 01, HBA4 = 01 Server 2 HBA1 = 02, HBA2 = 02, HBA3 = 02, HBA4 = 02

- For the second controller enclosures, Enclosures 2 and 4, set each controller host port ALPA to a different address then set on the first enclosures, Enclosures 1 and 3:  
 Controller Enclosure 1: Controller Host Port 1 = 71, Port 2 = 72  
 Controller Enclosure 2: Controller Host Port 1 = 73, Port 2 = 74  
 Controller Enclosure 3: Controller Host Port 1 = 71, Port 2 = 72  
 Controller Enclosure 4: Controller Host Port 1 = 73, Port 2 = 74
- Depending on your specific application needs, configure either for maximum LUNs or for maximum controller port paths.
- For Maximum LUN Count—Up to 64 LUNs with 4 active controller host ports. The suggested unit numbering and connection parameters that result in the units being distributed equally across enclosures and controller host ports follow:

For all Controller Enclosures, Server 1 and Server 2 units:

Port 1 units D0–D7, Port 2 units D100–D107

Prefer units D0–D3, D100–D103 to Controller A

Prefer units D4–D7, D104–D107 to Controller B

For Controller Enclosures 1 and 2, connection names, unit offset values: SRV1A1P1A, 0. SRV1A2P1B, 0. SRV1A1P2B, 100. SRV1A2P2A, 100. SRV2A1P1A, 0. SRV2A2P1B, 0. SRV2A1P2B, 100. SRV2A2P2A, 100.

Set exclusive access for each unit to the appropriate connection names, for example:

D0 ENABLE = SRV1A1P1A, SRV1A2P1B, SRV2A1P1A, SRV2A2P1B

D100 ENABLE = SRV1A1P2B, SRV1A2P2A, SRV2A1P2B, SRV2A2P2A

For Controller Enclosures 3 and 4, connection names, unit offset values: SRV1A3P1A, 0. SRV1A4P1B, 0. SRV1A3P2B, 100. SRV1A4P2A, 100. SRV2A3P1A, 0. SRV2A4P1B, 0. SRV2A3P2B, 100. SRV2A4P2A, 100.

Set exclusive access for each unit to the appropriate connection names, for example:

D0 ENABLE = SRV1A3P1A, SRV1A4P1B, SRV2A3P1A, SRV2A4P1B

D100 ENABLE = SRV1A3P2B, SRV1A4P2A, SRV2A3P2B, SRV2A4P2A

- For Maximum Controller Port PATH Accessibility—Up to 32 LUNs when configured for maximum paths, the suggested unit numbering and connection parameters that result in 8 LUNs being accessible through 4 ports in each controller enclosure follow:

For all Controller Enclosures, Server 1 and Server 2 units D0–D7

Prefer units D0–D3 to Controller A

Prefer units D4–D7 to Controller B

For Controller Enclosures 1 and 2, connection names, unit offset values: SRV1A1P1A, 0. SRV1A2P1B, 0. SRV1A1P2B, 0. SRV1A2P2A, 0. SRV2A1P1A, 0. SRV2A2P1B, 0. SRV2A1P2B, 0. SRV2A2P2A, 0.

Set exclusive access for each unit to the appropriate connection names, for example:

D0 ENABLE = SRV1A1P1A, SRV1A2P1B, SRV2A1P1A, SRV2A2P1B, SRV1A1P2B, SRV1A2P2A, SRV2A1P2B, SRV2A2P2A

For Controller Enclosures 3 and 4, connection names, unit offset values: SRV1A3P1A, 0. SRV1A4P1B, 0. SRV1A3P2B, 0. SRV1A4P2A, 0. SRV2A3P1A, 0. SRV2A4P1B, 0. SRV2A3P2B, 0. SRV2A4P2A, 0.

Set exclusive access for each unit to the appropriate connection names, for example:

D0 ENABLE = SRV1A3P1A, SRV1A4P1B, SRV2A3P1A, SRV2A4P1B, SRV1A3P2B, SRV1A4P2A, SRV2A3P2B, SRV2A4P2A

- Unit configurations and numbering can be identical for each storage enclosure, as each server will see each active controller host port as a unique target ID with a unique set of LUNs.

## HA Configuration 5 Performance Considerations

This configuration uses 4 dual controller pairs with an overall aggregate limit based on a theoretical four-loop limit of 62,400 I/O/sec and 400 MB/sec data rate. The primary advantage of this configuration is the ability to connect up to four storage systems with redundant independent paths to the servers.

This is a high availability, high capacity configuration that can be used for extremely intensive I/O applications and extremely intensive bandwidth applications.

## HA Configuration 6—Four Servers, MSCS, Secure Path, Dual Controller, Multiple-bus Failover, Two Independent Clusters, Shared Storage Enclosure

HA Configuration 6 (Figure 24) builds on configurations 3 and 4, combining the benefits of MSCS clustering, Secure Path for Windows NT/Windows 2000 software, controller redundancy, and sharing of the storage enclosure. The configuration provides two independent clusters with two separate physical paths to the storage through two pairs of controller host ports. In the event of a failure of any component within the access path – Fibre Channel host bus adapter, cables, hub, or controller host port interface, all units on the failing path will become accessible through the alternate path. In the event of a server failure, cluster failover will be invoked to provide access to units through the surviving server. Each Windows NT/Windows 2000 Cluster can be configured with up to 8 LUNs. The two clusters share the storage enclosure in that each cluster has exclusive access to its own LUNs through the use of mutually exclusive LUN numbering. An additional 48 disks can be added using two expansion enclosures to increase storage capacity.

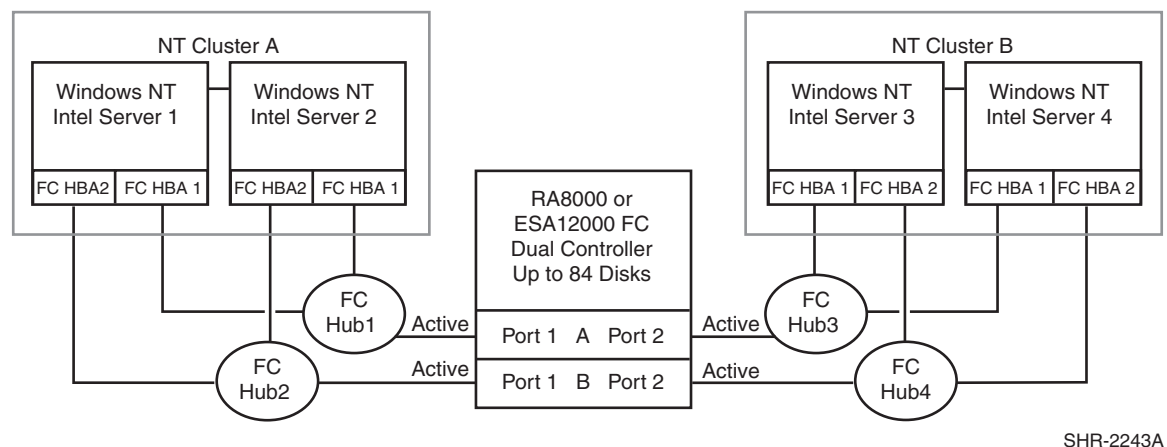


Figure 24: HA configuration 6

## HA Configuration 6 Notes

- Four Fibre Channel loops

- Uses Secure Path for Windows NT/Windows 2000 (minimum V3.0). Dynamic load distribution is not available in this configuration
- One instance of Secure Path Manager can control all paths.
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 84 disks
- Up to 16 LUNs total/8 per Cluster with 4 active controller host ports. Suggested controller unit number and offset value assignment: Port 1 units D0–D7, unit offset = 0, Port 2 units D100–D107, unit offset 100
- Set the Unit Preferred Path. Use the Preferred Path unit parameter to distribute units equally across controllers for load balancing.
  - Prefer units D0–D3 to Controller A
  - Prefer units D4–D7 to Controller B
  - Prefer units D100–D103 to Controller A
  - Prefer units D104–D107 to Controller B
- In this configuration 8 logical connections are available, rename the connection names, for example:
  - SERV1P1A, SERV1P1B, SERV2P1A, SERV2P1B
  - SERV3P2A, SERV3P2B, SERV4P2A, SERV4P2B
- Set exclusive unit access for each unit to specific server connection names. For example: for unit D0 ENABLE = SERV1P1A, SERV1P1B, SERV2P1A, SERV2P1B; for unit D100 ENABLE = SERV3P2A, SERV3P2B, SERV4P2A, SERV5P2B
- Set the connection name unit offset values for each connection as shown below.
- In each server set the ALPA for each Fibre Channel host bus adapter to the same hexadecimal hard address, but unique on the loop. Suggested settings: Server 1 HBA1 = 01, HBA2 = 01, Server 2 HBA1 = 02, HBA2 = 02, and so forth.
- Suggested unit numbering and connection parameters would result in the units being distributed equally across clusters/controller host ports as follows:
  - Server 1: Port 1 units D0–D7
  - Connection names, unit offset values: SERV1P1A, 0. SERV1P1B, 0
  - Server 2: Port 1 units D0–D7
  - Connection names, unit offset values: SERV2P1A, 0. SERV2P1B, 0
  - Server 3: Port 2 units D100–D107
  - Connection names, unit offset values: SERV3P2A, 100. SERV3P2B, 100
  - Server 4: Port 2 units D100–D107
  - Connection names, unit offset values: SERV4P2A, 100. SERV4P2B, 100

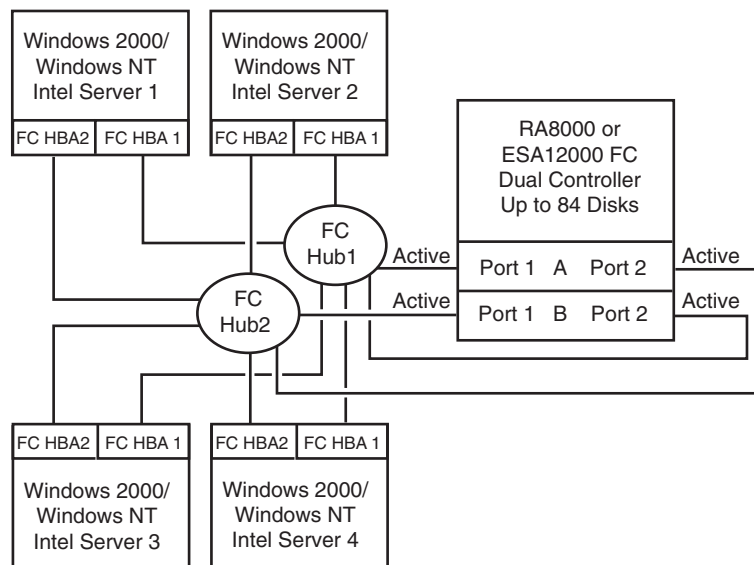
## HA Configuration 6 Performance Considerations

This configuration uses dual controllers with four active controller host ports. The overall limit is based on the dual controller, four active port limit of 24,000(cache)/8,200(media) I/O/sec and 195(cache)/102(media) MB/sec data rate. The primary advantage of this configuration is the ability to share the storage enclosure to connect two independent clusters with redundant independent paths to the storage.

This is a general-purpose configuration that can be used for intensive I/O applications and extremely intensive bandwidth applications.

### HA Configuration 7—Up to Four Servers, Secure Path, Dual Controller, Multiple-bus Failover, Shared Storage Enclosure

HA Configuration 7 (Figure 25) builds on Configuration 1 providing storage for up to four separate (non-cooperating) servers on two Fibre Channel loops. The four servers share the storage enclosure in that each server has exclusive access to its own set of LUNs. This is made possible by the setting of explicit “connection name access” at the unit level and using connection name “unit offsets” to give each server an accessible range of unit numbers. Additional levels of access control are necessary for this configuration because all servers are sharing the two Fibre Channel loops. The configuration utilizes two separate paths to the storage from each server. In the event of a failure of any component within the access path – host bus adapters, cables, hub, or controller host port interface, all LUNs on the failing path will become accessible through the alternate path.



SHR-2247A

**Figure 25: HA configuration 7**

### HA Configuration 7 Notes

- Two Fibre Channel loops
- Shared storage enclosure
- Uses Secure Path for Windows NT/Windows 2000 (minimum V3.0). Dynamic load distribution is available in this configuration when configured for maximum controller port paths.
- One instance of Secure Path Manager can control all paths.
- Dual HSG80 controllers configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 84 disks
- In this configuration 16 logical connections are available.

- In each server, set the ALPA for each Fibre Channel host bus adapter to the same hexadecimal hard address, but unique on the loop suggested settings, Server 1 HBA1 = 01, HBA2 = 01, Server 2 HBA1 = 02, HBA2 = 02, and so forth.
- Depending on your specific application needs, configure either for maximum LUNs or for maximum controller port paths.
- For Maximum LUN Count—Up to 64 LUNs, 16 available to each server with 4 active controller host ports. The suggested unit numbering and connection parameters that result in the units being distributed equally across controller host ports follow:

Server 1 Port 1 units D0–D7, Port 2 units D100–D107

Prefer units D0–D3, D100–D103 to Controller A

Prefer units D4–D7, D104–D107 to Controller B

Connection names, unit offset values: SRV1A1P1A, 0. SRV1A2P1B, 0. SRV1A1P2B, 100. SRV1A2P2A, 100.

Set exclusive access for each unit to the listed connection names, for example: D0 ENABLE = SRV1A1P1A, SRV1A2P1B. D100 ENABLE = SRV1A1P2B, SRV1A2P2A.

Server 2 Port 1 units D10–D17, Port 2 units D110–D117

Prefer units D10–D13, D110–D113 to Controller A

Prefer units D14–D17, D114–D117 to Controller B

Connection names, unit offset values: SRV2A1P1A, 10. SRV2A2P1B, 10. SRV2A1P2B, 110. SRV2A2P2A, 110.

Set exclusive access for each unit to the listed connection names, for example: D10 ENABLE = SRV2A1P1A, SRV2A2P1B. D110 ENABLE = SRV2A1P2B, SRV2A2P2A

Server 3 Port 1 units D20–D27, Port 2 units D120–D127

Prefer units D20–D23, D120–D123 to Controller A

Prefer units D24–D27, D124–D127 to Controller B

Connection names, unit offset values: SRV3A1P1A, 20. SRV3A2P1B, 20. SRV3A1P2B, 120. SRV3A2P2A, 120.

Set exclusive access for each unit to the listed connection names, for example: D20 ENABLE = SRV3A1P1A, SRV3A2P1B. D120 ENABLE = SRV3A1P2B, SRV3A2P2A

Server 4 Port 1 units D30–D37, Port 2 units D130–D137

Prefer units D30–D33, D130–D133 to Controller A

Prefer units D34–D37, D134–D137 to Controller B

Connection names, unit offset values: SRV4A1P1A, 30. SRV4A2P1B, 30. SRV4A1P2B, 130. SRV4A2P2A, 130.

Set exclusive access for each unit to the listed connection names, for example: D30 ENABLE = SRV4A1P1A, SRV4A2P1B. D130 ENABLE = SRV4A1P2B, SRV4A2P2A

- For Maximum Controller Port PATH Accessibility—Up to 32 LUNs, 8 available to each server with 4 active controller host ports and dynamic load distribution between two ports on the same controller. The suggested unit numbering and connection parameters that result in 8 LUNs for each server being accessible through all 4 controller ports follow:

Server 1 units D0–D7

Prefer units D0–D3 to Controller A

Prefer units D4–D7 to Controller B

Connection names, unit offset values: SRV1A1P1A, 0. SRV1A2P1B, 0. SRV1A1P2B, 0. SRV1A2P2A, 0.

Set exclusive access for each unit to the listed connection names, for example: D0  
ENABLE = SRV1A1P1A, SRV1A2P1B, SRV1A1P2B, SRV1A2P2A

Server 2 units D10–D17

Prefer units D10–D13 to Controller A

Prefer units D14–D17 to Controller B

Connection names, unit offset values: SRV2A1P1A, 10. SRV2A2P1B, 10. SRV2A1P2B, 10. SRV2A2P2A, 10.

Set exclusive access for each unit to the listed connection names, for example: D10  
ENABLE = SRV2A1P1A, SRV2A2P1B, SRV2A1P2B, SRV2A2P2A

Server 3 units D20–D27

Prefer units D20–D23 to Controller A

Prefer units D24–D27 to Controller B

Connection names, unit offset values: SRV3A1P1A, 20. SRV3A2P1B, 20. SRV3A1P2B, 20. SRV3A2P2A, 20.

Set exclusive access for each unit to the listed connection names, for example: D20  
ENABLE = SRV3A1P1A, SRV3A2P1B, SRV3A1P2B, SRV3A2P2A

Server 4 units D30–D37

Prefer units D30–D33 to Controller A

Prefer units D34–D37 to Controller B

Connection names, unit offset values: SRV4A1P1A, 30. SRV4A2P1B, 30. SRV4A1P2B, 30. SRV4A2P2A, 30.

Set exclusive access for each unit to the listed connection names, for example: D30  
ENABLE = SRV4A1P1A, SRV4A2P1B, SRV4A1P2B, SRV4A2P2A

## HA Configuration 7 Performance Considerations

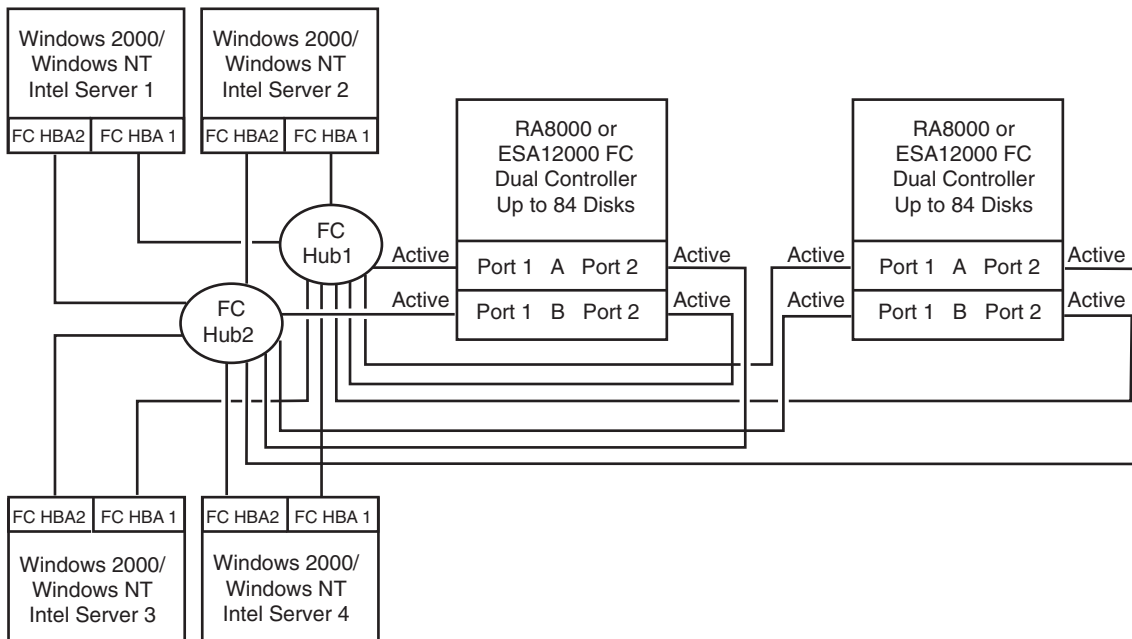
This configuration uses dual controllers with two active controller host ports. The overall aggregate limit is based on the dual controller, four active port limit of 24,000(cache)/8,200(media) I/O/sec and 195(cache)/102(media) MB/sec data rate. The primary advantage of this configuration is the ability to provide redundant independent paths to the storage for up to four servers.

This is a general-purpose configuration that can be used for intensive I/O applications and extremely intensive bandwidth applications.

## HA Configuration 8—Up to Four Servers, Secure Path, Two Dual Controller Pairs, Multiple-bus Failover, Shared Storage Enclosure

HA Configuration 8 (Figure 26) builds on Configuration 7 by adding storage capacity using a second enclosure and second pair of controllers. The second pair of controllers are connected to two Fibre Channel loops providing redundant paths for up to four separate (non-cooperating) servers. The four servers share both storage enclosures in that each server has exclusive access to its own LUNs in each enclosure through the use of mutually exclusive LUN numbering, explicit unit host access, and the use of connection unit offsets. Additional levels of access control are necessary for this configuration because all servers are sharing the

two Fibre Channel loops. The configuration uses two separate paths to the storage from each server. In the event of a failure of any component within the access path—host bus adapter, cables, hub, or controller host port interface, all LUNs on the failing path will become accessible through the alternate path.



SHR-2248A

**Figure 26: HA configuration 8**

### HA Configuration 8 Notes

- Two Fibre Channel loops
- Shared storage enclosure
- Uses Secure Path for Windows NT/Windows 2000 (minimum V3.0). Dynamic load distribution is available in this configuration when configured for maximum controller port paths.
- One instance of Secure Path Manager can control all paths.
- Two Dual HSG80 controller pairs configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 168 disks
- In this configuration 16 logical connections are available, 8 in each enclosure.
- In each server set the ALPA for each Fibre Channel host bus adapter to the same hexadecimal hard address, but unique on the loop. Suggested settings: Server 1 HBA1 = 01, HBA2 = 01, Server 2 HBA1 = 02, HBA2 = 02, and so forth.
- For the second controller enclosure, Enclosure 2, set each controller host port ALPA to a different address then set on the first enclosure:
- Controller Enclosure 1: Controller Host Port 1 = 71, Port 2 = 72
- Controller Enclosure 2: Controller Host Port 1 = 73, Port 2 = 74
- Depending on your specific application needs, configure either for maximum LUNs or for maximum controller port paths.

- For Maximum LUN Count—Up to 128 LUNs, 32 available to each server with 8 active controller host ports. Refer to Configuration 7, “Maximum LUN Count” Controller Enclosure settings for a suggested way to define the units that distributes them equally across controller host ports. Unit configurations and numbering can be identical for each storage enclosure, as each server will see each active controller host port as a unique target ID with a unique set of LUNs.
- For Maximum Controller Port PATH Accessibility—Up to 64 LUNs, 16 available to each server with 8 active controller host ports and dynamic load distribution between two ports on the same controller. Refer to Configuration 7, Controller Enclosure “Maximum Controller Port PATH Accessibility” settings for a suggested way to define the units that distributes them equally across controller host ports. Unit configurations and numbering can be identical for each storage enclosure, as each server will see each active controller host port as a unique target ID with a unique set of LUNs.

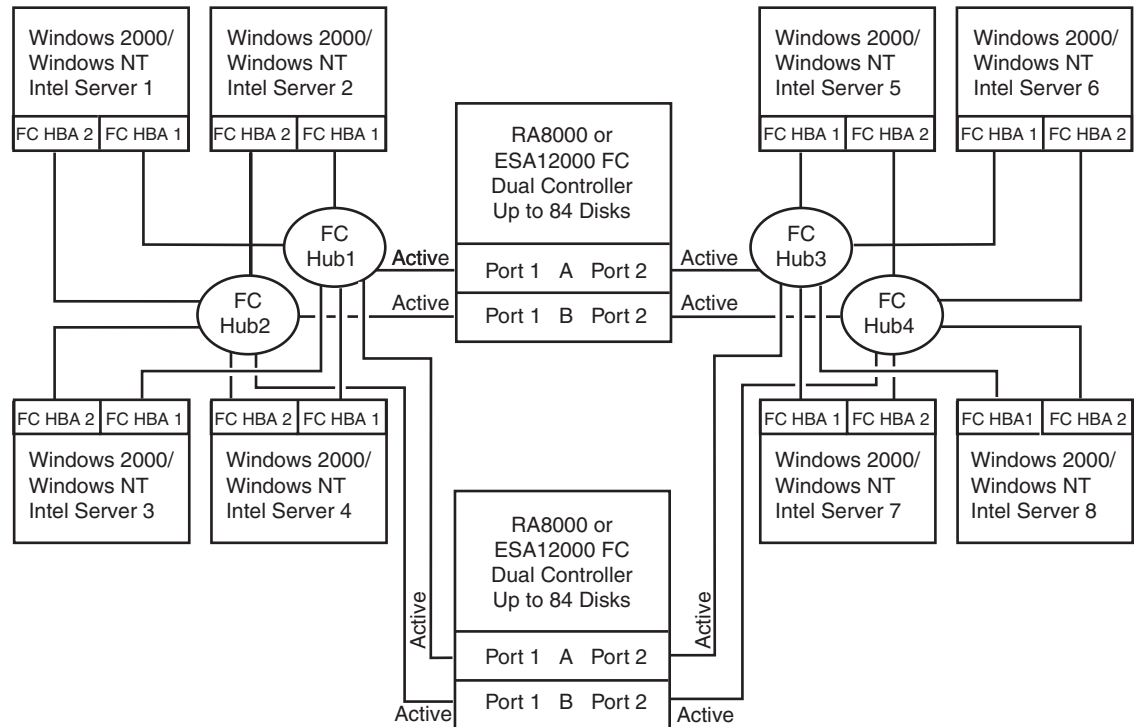
### HA Configuration 8 Performance Considerations

This configuration uses 2 dual controller pairs with an overall aggregate limit based on a theoretical two-loop limit of 33,200 I/O/sec and 200 MB/sec data rate. The primary advantage of this configuration is the ability to connect up to four servers and two storage systems with redundant independent paths to the storage.

This is a high availability, high connectivity configuration that can be used for extremely intensive I/O applications and extremely intensive bandwidth applications.

### HA Configuration 9—Up to Eight Servers, Secure Path, Two Dual Controller Pairs, Multiple-bus Failover, Two Shared Storage Enclosures

Configuration 9 (Figure 27) builds on Configurations 7 and 8 using two dual controller pairs on four loops to provide storage path and controller redundancy for up to eight separate (non-cooperating) servers. The eight servers share both storage enclosures in that each server has exclusive access to its own LUNs in each enclosure through the use of mutually exclusive LUN numbering, explicit unit host access, and the use of connection unit offsets. Additional levels of access control are necessary for this configuration because each group of four servers is sharing two Fibre Channel loops. The configuration uses two separate paths to the storage from each server. In the event of a failure of any component within the access path—host bus adapter, cables, hub, or controller host port interface, all LUNs on the failing path will become accessible through the alternate path.



SHR-2249A

**Figure 27: HA configuration 9**

## HA Configuration 9 Notes

- Four Fibre Channel loops
- Shared storage enclosure
- Uses Secure Path for Windows NT/Windows 2000 (minimum V3.0). Dynamic load distribution is not available in this configuration.
- One instance of Secure Path Manager can control all paths.
- Two Dual HSG80 controller pairs configured in Multiple-Bus Failover Mode
- Up to 500 meters per cable segment
- Up to 144 disks with 4 optional expansion cabinets
- In this configuration 32 logical connections are available, 16 in each enclosure.
- In each server set the ALPA for each Fibre Channel host bus adapter to the same hexadecimal hard address, but unique on the loop. Suggested settings: Server 1 HBA1 = 01, HBA2 = 01, Server 2 HBA1 = 02, HBA2 = 02, and so forth.
- For the second controller enclosure, Enclosure 2, set each controller host port ALPA to a different address then set on the first enclosure:
- Controller Enclosure 1: Controller Host Port 1 = 71, Port 2 = 72
- Controller Enclosure 2: Controller Host Port 1 = 73, Port 2 = 74
- Up to 128 LUNs, 16 available to each server with 8 active controller host ports. The suggested unit numbering and connection parameters that result in the units being distributed equally across controller host ports follow:  
Server 1 Port 1 units D0–D7

Prefer units D0–D3 to Controller A

Prefer units D4–D7 to Controller B

Connection names, unit offset values: SRV1A1P1A, 0. SRV1A2P1B, 0.

Set exclusive access for each unit to the listed connection names, for example: D0  
ENABLE = SRV1A1P1A, SRV1A2P1B

Server 2 Port 1 units D10–D17

Prefer units D10–D13 to Controller A

Prefer units D14–D17 to Controller B

Connection names, unit offset values: SRV2A1P1A, 10. SRV2A2P1B, 10.

Set exclusive access for each unit to the listed connection names, for example: D10  
ENABLE = SRV2A1P1A, SRV2A2P1B

Server 3 Port 1 units D20–D27

Prefer units D20–D23 to Controller A

Prefer units D24–D27 to Controller B

Connection names, unit offset values: SRV3A1P1A, 20. SRV3A2P1B, 20.

Set exclusive access for each unit to the listed connection names, for example: D20  
ENABLE = SRV3A1P1A, SRV3A2P1B

Server 4 Port 1 units D30–D37

Prefer units D30–D33 to Controller A

Prefer units D34–D37 to Controller B

Connection names, unit offset values: SRV4A1P1A, 30. SRV4A2P1B, 30.

Set exclusive access for each unit to the listed connection names, for example: D30  
ENABLE = SRV4A1P1A, SRV4A2P1B

Server 5 Port 2 units D100–D107

Prefer units D100–D103 to Controller A

Prefer units D104–D107 to Controller B

Connection names, unit offset values: SRV5A1P2B, 100. SRV5A2P2A, 100.

Set exclusive access for each unit to the listed connection names, for example: D100  
ENABLE = SRV5A1P2B, SRV5A2P2A

Server 6 Port 2 units D110–D117

Prefer units D110–D113 to Controller A

Prefer units D114–D117 to Controller B

Connection names, unit offset values: SRV6A1P2B, 110. SRV6A2P2A, 110.

Set exclusive access for each unit to the listed connection names, i.e D110 ENABLE =  
SRV6A1P2B, SRV6A2P2A

Server 7 Port 2 units D120–D127

Prefer units D120–D123 to Controller A

Prefer units D124–D127 to Controller B

Connection names, unit offset values: SRV7A1P2B, 120. SRV7A2P2A, 120.

Set exclusive access for each unit to the listed connection names, i.e D120 ENABLE = SRV7A1P2B, SRV7A2P2A.

Server 8 Port 2 units D130–D137

Prefer units D130–D133 to Controller A

Prefer units D134–D137 to Controller B

Connection names, unit offset values: SRV8A1P2B, 130. SRV8A2P2A, 130.

Set exclusive access for each unit to the listed connection names, i.e D130 ENABLE = SRV8A1P2B, SRV8A2P2A.

- Unit configurations and numbering can be identical for each storage enclosure, as each server will see each active controller host port as a unique target ID with a unique set of LUNs.

## HA Configuration 9 Performance Considerations

This configuration uses 2 dual controller pairs with an overall aggregate limit based on the dual controller four active port limit (times 2) of 48,000(cache) I/O/sec and 390(cache) MB/sec data rate. The primary advantage of this configuration is the ability to connect up to eight servers and two storage systems with redundant independent paths to the storage.

This is a high availability, high connectivity configuration that can be used for extremely intensive I/O applications and extremely intensive bandwidth applications.

## Appendix C: Controller Failover Transitions

This appendix provides the procedures for setting dual-redundant HSG80 controllers from one failover state to another. Controllers can exist in one of the following failover states:

- Transparent Failover (TF);
- Multiple-Bus Failover (MBF); and,
- NoFailover (NF).

The following controller failover state changes are discussed in this appendix:

- Transparent Failover to NoFailover Mode
- Transparent Failover to Multiple-bus Failover Mode
- Multiple-bus Failover to NoFailover and then to Transparent Failover Mode

---

### Note:

- To change the failover state of a controller, connect a serial line to the top controller. This will be referenced as THIS\_CONTROLLER.
  - The second controller will be referenced as the OTHER\_CONTROLLER.
  - All commands directed to the RAID storage system (that is, those preceded by HSG80> prompt), must be issued through this serial connection to the top controller.
- 

Verify the current state of the controllers by entering:

```
HSG80> SHOW THIS_CONTROLLER
```

The display from the SHOW command has a number of sections. The information required for changing a controller failover state is located in the first section, under the “Controller:” heading. A sample display for Transparent Failover is shown below, and the failover state is identified with an arrow, “->” preceding the text of note.

### Example

Controller:

```
HSG80 ZG83502145 Software V85F-0, Hardware E03
NODE_ID = 5000-1FE1-0000-3350
ALLOCATION_CLASS = 0
SCSI_VERSION = SCSI-2
-> Configured for dual-redundancy with ZG80200290
-> In dual-redundant configuration
```

When a controller state is changed using the procedures described in one of the next sections, the display will be refreshed to verify that the change has completed successfully.

## Changing from Transparent Failover to NoFailover Mode

1. At the HSG80> prompt, enter:

```
HSG80> SET NOFAILOVER
```

This action will cause the OTHER\_CONTROLLER to shutdown.

2. At the HSG80> prompt, enter:

```
HSG80> SHOW THIS_CONTROLLER
```

From the resulting display, verify that the controller state has changed to no failover.

**Example:**

Controller:

```
HSG80 ZG83502145 Software V85F-0, Hardware E03
NODE_ID = 5000-1FE1-0000-3350
ALLOCATION_CLASS = 0
SCSI_VERSION = SCSI-2
-> Not Configured for dual-redundancy
```

3. Restart the OTHER\_CONTROLLER by pressing the RESET button on the OTHER\_CONTROLLER.

The OTHER\_CONTROLLER will sound an alarm as it discovers the second controller but detects that it is not bound in a failover mode. The alarm (may be silenced) and the message about the controllers being misconfigured may be disregarded.

4. To verify the change in controller state, enter:

```
HSG80> SHOW THIS_CONTROLLER
```

**Example:**

Controller:

```
HSG80 ZG83502145 Software V85F-0, Hardware E03
NODE_ID = 5000-1FE1-0000-3350
ALLOCATION_CLASS = 0
SCSI_VERSION = SCSI-2
-> Not Configured for dual-redundancy
-> Controller misconfigured -- other controller present
```

## Changing from Transparent Failover to Multi-bus Failover Mode

Whether there are defined UNITs or not for the RAID system, the following steps will implement Transparent Failover to Multi-bus Failover:

1. At the HSG80> prompt, enter:

```
HSG80> SET NOFAILOVER
```

This action will cause the OTHER\_CONTROLLER to shutdown.

2. At the HSG80> prompt, enter:

```
HSG80> SHOW THIS_CONTROLLER
```

From the resulting display, verify that the controller state has changed to no failover.

**Example:**

Controller:

```
HSG80 ZG83502145 Software V85F-0, Hardware E03
NODE_ID = 5000-1FE1-0000-3350
ALLOCATION_CLASS = 0
SCSI_VERSION = SCSI-2
-> Not Configured for dual-redundancy
```

3. Restart the OTHER\_CONTROLLER by pressing the RESET button on the OTHER\_CONTROLLER.

The OTHER\_CONTROLLER will sound an alarm as it discovers the second controller but knows that it is not bound in a failover mode. The alarm (may be silenced) and the message about the controllers being misconfigured may be disregarded.

**Example:**

Controller:

```
HSG80 ZG83502145 Software V85F-0, Hardware E03
NODE_ID = 5000-1FE1-0000-3350
ALLOCATION_CLASS = 0
SCSI_VERSION = SCSI-2
-> Not Configured for dual-redundancy
Controller misconfigured -- other controller present
```

4. When the OTHER\_CONTROLLER is on-line, enter the following command to put the controllers into Multi-bus Failover mode:

```
HSG80> SET MULTIBUS_FAILOVER COPY=THIS
```

This action will copy all unit and connection information to the OTHER\_CONTROLLER and restart both controllers.

After both controllers have restarted, the controller pair will be bound in Multi-bus Failover mode with consistent views of all the RAID system information.

5. Verify that the controllers are now in Multi-bus failover by entering the following command:

```
HSG80> SHOW THIS_CONTROLLER
```

**Example:**

Controller:

```
HSG80 ZG83502145 Software V85F-0, Hardware E03
NODE_ID = 5000-1FE1-0000-3350
ALLOCATION_CLASS = 0
SCSI_VERSION = SCSI-2
-> Configured for MULTIBUS_FAILOVER with ZG80200290
-> In dual-redundant configuration
```

6. If the RAID system had connections prior to making this transition, display the connections and examine their “offset value” (last column), by entering the following command:

```
HSG80> SHOW CONNECTIONS
```

---

**Note:** In Transparent Failover mode, the controller, by default, assigns an offset value of 0 to the left hand port and an offset value of 100 to the right hand port. In Multi-bus Failover mode, the controller assigns an offset value of 0 to all ports, unless existing connections have non-zero offset values.

Secure Path software requires connections to be reset to zero (0) so that both paths will be able to access the entire set of UNITS on the RAID system. To reset the connections to zero, enter:

```
HSG80> SET CONNECTION connection_name UNIT_OFFSET=0
```

---

Repeat for each connection.

## Changing from Multi-bus Failover Mode to NoFailover and Then to Transparent Failover Mode

1. Inspect the “Connections:” display for connections on the storage system by entering the following command:

```
HSG80> SHOW CONNECTIONS
```

Delete all connections by entering the following command for each connection found:

```
HSG80> DELETE connection_name (Repeat for each connection).
```

---

**Note:** The connections will be regenerated later.

---

If there are units (Dn) on the storage system, they must be deleted. This is due to the inconsistencies incorporated in the volumes' WWID in different failover modes.

```
HSG80> SHOW UNITS
```

```
HSG80> DELETE Dn (for each Dn)
```

---

**Note:** The UNITS will be restored after the controller state is changed. It is advised that the Dn values and associated information as well as the storage set information be recorded for later use. The controller state change will not affect the data on the storage sets.

---

2. If the controllers are currently in a failover mode, enter:

```
HSG80> SET NOFAILOVER
```

This action will cause the OTHER\_CONTROLLER to shutdown.

Verify the current state of the controller by entering:

```
HSG80> SHOW THIS_CONTROLLER
```

Example:

Controller:

```
HSG80 ZG83502145 Software V85F-0, Hardware E03
```

```
NODE_ID = 5000-1FE1-0000-3350
```

```
ALLOCATION_CLASS = 0
```

```
SCSI_VERSION = SCSI-2
```

```
-> Not Configured for dual-redundancy
```

3. Restart the OTHER\_CONTROLLER by pressing the RESET button on the OTHER\_CONTROLLER. The OTHER\_CONTROLLER will sound an alarm as it discovers the second controller but knows that it is not bound in a failover mode. The alarm (may be silenced) and the message about the controllers being misconfigured may be disregarded.

Verify the current state of the controller by entering:

```
HSG80> SHOW THIS_CONTROLLER
```

**Example:**

Controller:

HSG80 ZG83502145 Software V85F-0, Hardware E03

NODE\_ID = 5000-1FE1-0000-3350

ALLOCATION\_CLASS = 0

SCSI\_VERSION = SCSI-2

-&gt; Not Configured for dual-redundancy

-&gt; Controller misconfigured -- other controller present

4. When the OTHER\_CONTROLLER is available, enter:

HSG80&gt; SET FAILOVER COPY=THIS

This action will copy all unit and configuration information to the OTHER\_CONTROLLER restart it. When restarted, the controller pair will be bound in Transparent Failover mode.

5. Verify the controller state change by entering:

HSG80&gt; SHOW THIS\_CONTROLLER

**Example:**

Controller:

HSG80 ZG83502145 Software V85F-0, Hardware E03

NODE\_ID = 5000-1FE1-0000-3350

ALLOCATION\_CLASS = 0

SCSI\_VERSION = SCSI-2

-&gt; Configured for dual-redundancy with ZG80200290

-&gt; In dual-redundant configuration

6. Restore the UNIT to storage set mapping that was recorded earlier. Enter:

HSG80&gt; ADD UNIT Dn storage\_set\_name

---

**WARNING:** Do not initialize the units. This action will destroy data on the storageset(s).

---

7. Restart both controllers to reacquire connections. Enter:

HSG80&gt; RESTART OTHER\_CONTROLLER

HSG80&gt; RESTART THIS\_CONTROLLER

An alternative method to reestablish the connections is to reboot the server(s).

## Appendix D: Arbitrated Loop Physical Addresses

Host/Server ALPAs. Lowest to Highest Priority

| ALPA<br>(hex) | Targ<br>(hex) | Targ<br>(dec) | ALPA<br>(hex) | Targ<br>(hex) | Targ<br>(dec) |
|---------------|---------------|---------------|---------------|---------------|---------------|
| 6E            | 42            | 66            | 3A            | 60            | 96            |
| 6D            | 43            | 67            | 39            | 61            | 97            |
| 6C            | 44            | 68            | 36            | 62            | 98            |
| 6B            | 45            | 69            | 35            | 63            | 99            |
| 6A            | 46            | 70            | 34            | 64            | 100           |
| 69            | 47            | 71            | 33            | 65            | 101           |
| 67            | 48            | 72            | 32            | 66            | 102           |
| 66            | 49            | 73            | 31            | 67            | 103           |
| 65            | 4A            | 74            | 2E            | 68            | 104           |
| 63            | 4B            | 75            | 2D            | 69            | 105           |
| 5C            | 4C            | 76            | 2C            | 6A            | 106           |
| 5A            | 4D            | 77            | 2B            | 6B            | 107           |
| 59            | 4E            | 78            | 2A            | 6C            | 108           |
| 56            | 4F            | 79            | 29            | 6D            | 109           |
| 55            | 50            | 80            | 27            | 6E            | 110           |
| 54            | 51            | 81            | 26            | 6F            | 111           |
| 53            | 52            | 82            | 25            | 70            | 112           |
| 52            | 53            | 83            | 23            | 71            | 113           |
| 51            | 54            | 84            | 1F            | 72            | 114           |
| 4E            | 55            | 85            | 1E            | 73            | 115           |
| 4D            | 56            | 86            | 1D            | 74            | 116           |
| 4C            | 57            | 87            | 1B            | 75            | 117           |
| 4B            | 58            | 88            | 18            | 76            | 118           |
| 4A            | 59            | 89            | 17            | 77            | 119           |
| 49            | 5A            | 90            | 10            | 78            | 120           |
| 47            | 5B            | 91            | 0F            | 79            | 121           |
| 46            | 5C            | 92            | 08            | 7A            | 122           |
| 45            | 5D            | 93            | 04            | 7B            | 123           |

| ALPA (hex) | Targ (hex) | Targ (dec) | ALPA (hex) | Targ (hex) | Targ (dec) |
|------------|------------|------------|------------|------------|------------|
| 43         | 5E         | 94         | 02         | 7C         | 124        |
| 3C         | 5F         | 95         | 01         | 7D         | 125        |

Reserved for FL\_PORT

|  |    |    |     |
|--|----|----|-----|
|  | 00 | 7E | 126 |
|--|----|----|-----|

## HSG80 Controller ALPAs

Lowest to Highest Priority

| ALPA (hex) | Targ(hex) | Targ (dec) | ALPA (hex) | Targ(hex) | Targ (dec) |
|------------|-----------|------------|------------|-----------|------------|
| EF         | 00        | 0          | B1         | 21        | 33         |
| E8         | 01        | 1          | AE         | 22        | 34         |
| E4         | 02        | 2          | AD         | 23        | 35         |
| E2         | 03        | 3          | AC         | 24        | 36         |
| E1         | 04        | 4          | AB         | 25        | 37         |
| E0         | 05        | 5          | AA         | 26        | 38         |
| DC         | 06        | 6          | A9         | 27        | 39         |
| DA         | 07        | 7          | A7         | 28        | 40         |
| D9         | 08        | 8          | A6         | 29        | 41         |
| D6         | 09        | 9          | A5         | 2A        | 42         |
| D5         | 0A        | 10         | A3         | 2B        | 43         |
| D4         | 0B        | 11         | 9F         | 2C        | 44         |
| D3         | 0C        | 12         | 9E         | 2D        | 45         |
| D2         | 0D        | 13         | 9D         | 2E        | 46         |
| D1         | 0E        | 14         | 9B         | 2F        | 47         |
| CE         | 0F        | 15         | 98         | 30        | 48         |
| CD         | 10        | 16         | 97         | 31        | 49         |
| CC         | 11        | 17         | 90         | 32        | 50         |
| CB         | 12        | 18         | 8F         | 33        | 51         |
| CA         | 13        | 19         | 88         | 34        | 52         |
| C9         | 14        | 20         | 84         | 35        | 53         |
| C7         | 15        | 21         | 82         | 36        | 54         |

| ALPA<br>(hex) | Targ(hex) | Targ<br>(dec) | ALPA<br>(hex) | Targ(hex) | Targ<br>(dec) |
|---------------|-----------|---------------|---------------|-----------|---------------|
| C6            | 16        | 22            | 81            | 37        | 55            |
| C5            | 17        | 23            | 80            | 38        | 56            |
| C3            | 18        | 24            | 7C            | 39        | 57            |
| BC            | 10        | 25            | 7A            | 3A        | 58            |
| BA            | 1A        | 26            | 79            | 3B        | 59            |
| B9            | 1B        | 27            | 76            | 3C        | 60            |
| B6            | 1C        | 28            | 75            | 3D        | 61            |
| B5            | 1D        | 29            | 74            | 3E        | 62            |
| B4            | 1E        | 30            | 73            | 3F        | 63            |
| B3            | 1F        | 31            | 72            | 40        | 64            |
| B2            | 20        | 32            | 71            | 41        | 65            |